J. of Microscopy

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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FOR THE YEAR

1890.

PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

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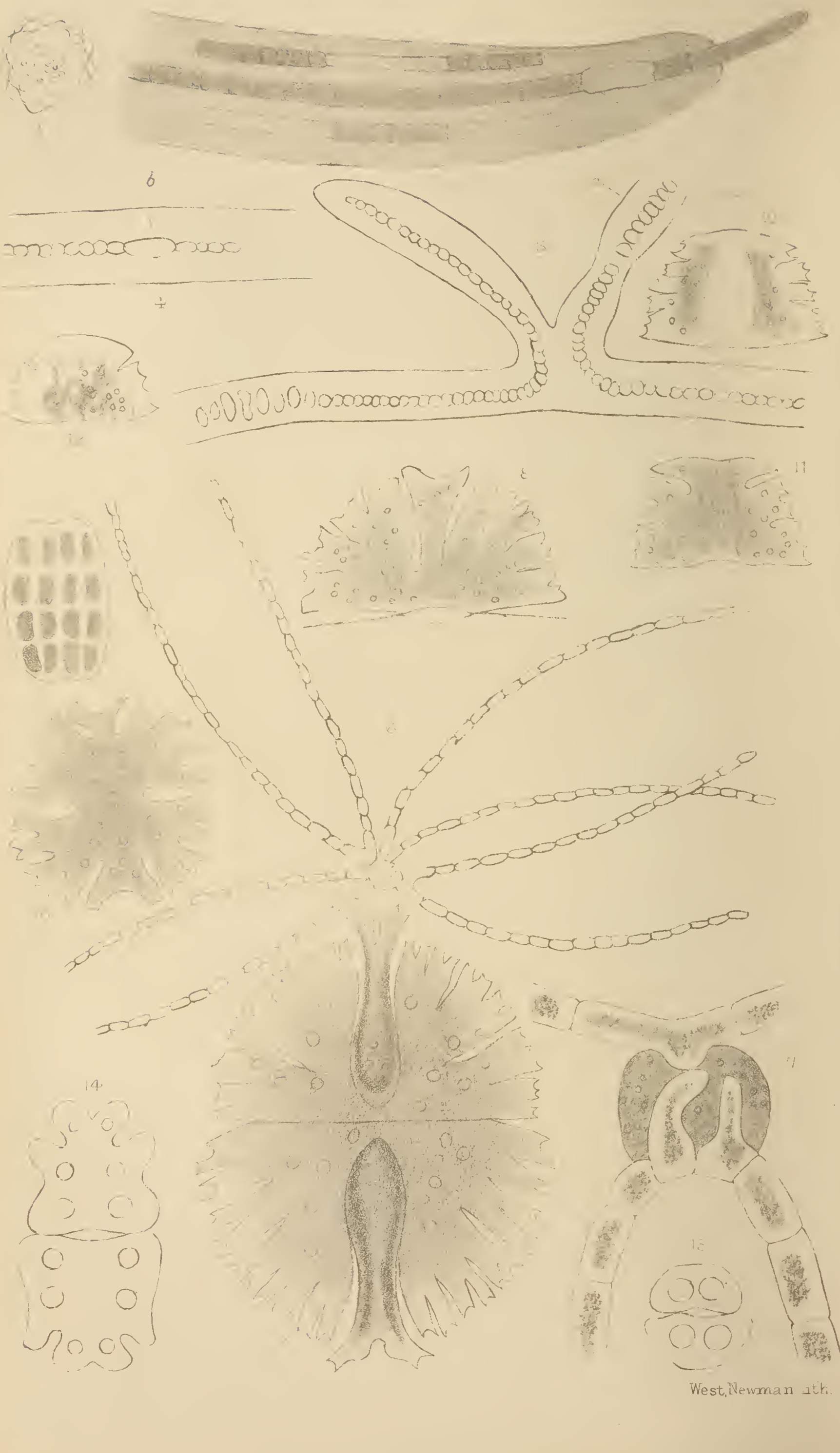

West, Newman lith.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1890.

TRANSACTIONS OF THE SOCIETY.

I.—*Freshwater Algæ and Schizophyceæ of Hampshire and Devonshire.*

By Alfred W. Bennett, M.A., B.Sc., F.L.S., F.R.M.S., Lecturer on Botany at St. Thomas's Hospital.

(*Read* 11*th December*, 1889.)

Plate I.

The gatherings of which the results are given in this paper were made in August 1888 and August 1889; the species observed in Hampshire are indicated by the letter H, those in Devonshire by D. Unless otherwise stated, the locality for the former is bogs and streams in the New Forest, in the neighbourhood of Lyndhurst; for the latter the south-eastern corner of Dartmoor and its outskirts, in the neighbourhood of Bovey Tracey and Buckfastleigh. Both in Desmids and in other families of Algæ the Hampshire localities were decidedly the richer, and I am unable to account for the comparative poverty of the Dartmoor gatherings, both in individuals and in species. The most

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EXPLANATION OF PLATE I.

(All multiplied 200 diameters unless otherwise stated.)

Fig. 1.—*Glochiococcus insignis* (De Ton.) Reinsch.
" 2.—*Schizothrix anglica* n. sp. (× 400).
" 3.—*Scytonema figuratum* Ag. (× 300); *a*, hormogone.
" 4.— " " (× 400); *b*, heterocyst.
" 5.—*Staurogeneis rectangularis* A. Br.
" 6.—*Rhizoclonium geminatum* n. sp. (× 100).
" 7.— " " (× 600).
" 8.—*Micrasterias denticulata* Bréb. var. *intermedia* n. var.
" 9.— " *rotata* Ralfs var. *urnigera* n. var.
" 10.— " *truncata* Bréb. var.
" 11.— " *crenata* Bréb. var.
" 12.— " " Bréb. var.
" 13.— " *crux-melitensis* Men.
" 14.—*Euastrum crasso-humerosum* n. var.
" 15.—*Cosmarium homalodermum* Nordst.

fruitful locality in the New Forest was the bog between Lyndhurst and Christchurch, so well known to botanists as the habitat of the rare *Spiranthes æstivalis.*

Very little work has been done with the Freshwater Algæ of the South-west of England since the time of Hassall, Ralfs, and Jenner. The only recent papers of importance with which I am acquainted are by Mr. E. D. Marquand, on "The Desmids and Diatoms of West Cornwall," and on "The Freshwater Algæ of the Land's End District," in the 'Transactions of the Penzance Natural History and Antiquarian Society' for 1882–3 and 1885–6; and by Mr. E. Parfitt on "Devon Freshwater Algæ," in the 'Transactions of the Devonshire Association for the Advancement of Science, Literature, and Art' for 1886. As in previous papers, I have excluded diatoms from the list. Species for which I could find no previously recorded locality in these islands are printed in italics; and new species or new varieties in small capitals. To the names of those desmids not previously recorded from the southern counties of England an * is prefixed.

Protococcaceæ.

Eremosphæra viridis DBy., H, D.
Glœocystis vesiculosa Näg., D.
„ rupestris Rbh., D.
Botryococcus Braunii Ktz., H.
Rhaphidium falcatum Cke., H.
Chlorococcum gigas Grün., H.
Schizochlamys gelatinosa A. Br., D.
Scenedesmus acutus Mey., H.
„ obtusus, Mey., H, D.
Glochiococcus insignis (De Ton.) Reinsch (Acanthococcus insignis Reinsch, Ber. Deutsch. Bot. Gesell., iv. 1886, pl. xii. f. 22), H. Fig. 1.

This interesting organism was observed very rarely in bog-pools near Lyndhurst. It corresponds very closely with Reinsch's description and figure. The total diameter of the cell is about 67·5 μ. The cell-wall is exceedingly thick, as much as one-fourth the diameter of the cell, and consists of a large number of plicated layers, the cell-cavity filled with granular protoplasm and containing large chromatophores. I have already recorded (Journ. R. Micr. Soc., 1888, p. 2, pl. i. f. 4) the occurrence in this country of a spiny species of this genus, which I have described as a new species under the name *Acanthocladus anglicus* mihi,* which may, however, be but a form of this.

Characiaceæ.

Nephrocytium Nägelii Grün., Beaulieu, H.

* See Note at the end of this paper.

CHROOCOCCACEÆ.

Chroococcus turgidus Näg., H.
Aphanocapsa virescens Rbh., H.
Merismopedia glauca Näg., H, D.

OSCILLARIACEÆ.

Oscillaria tenerrima Ktz., H.
„ princeps Vauch., H.
SCHIZOTHRIX ANGLICA n. sp., H. Fig. 2.

Trichomes very long and slender, unbranched, about 5 μ in diameter; two or more inclosed in a common mucilaginous sheath. Sheath 6–10 times as broad as the trichomes, pale yellow, diffluent (ultimately brown?), somewhat lamellose. This interesting genus of Oscillariaceæ is new to Britain; the submarine species, *Schizothrix Creswellii,* described by Harvey, and found by him, and again recently by Parfitt, at Sidmouth, being referred by Thuret, no doubt correctly, to *Inactis.* The organism was found sparingly in a bog-pool near Lyndhurst. It does not seem to me to agree fully with any species hitherto described, differing from them in the extreme fineness of the trichomes. It comes nearest to *S. Mülleri* Näg., apparently known only from the neighbourhood of Zürich; but may very probably be identical with *Dasygloia amorpha* Thw., found in England by Berkeley, the descriptions of which are very imperfect. Bornet (*in litt.*) is inclined to sink both *Schizothrix* and *Dasygloia* in *Microcoleus,* characterized by the inclusion of a number of trichomes in the same general sheath. They present the peculiarity of the narrowing of the common sheath at the lower end into a kind of tube, from which portions of the trichomes escape in the form of hormogones.

SCYTONEMACEÆ.

Stigonema minutum Hass., H, D.
Scytonema figuratum Ag. (S. calothrichoides Ktz.), H. Figs. 3, 4.

Sheath translucent, pale yellow throughout, about 25 μ in diameter. Trichomes green, composed of pseudocysts, about 4 μ broad, and about as long as broad, or longer in the lower part of the trichome; heterocysts elliptical, about twice as long as broad, 20×10 μ. Branches always geminate, usually short, and of somewhat less diameter than the main filament. A slenderer species than *S. myochrous* Ag., which has been recorded from Cornwall by Marquand. Bogs, Lyndhurst. A widely distributed species, not mentioned in Cooke's 'British Freshwater Algæ,' stated to have occurred in England by Bornet and Flahault on the authority of Berkeley, but without any locality.

Tolypothrix lanata Wartm., H.

Trichome very slender, single, or sometimes two more or less parallel included in a sheath; not more than 10 μ in diameter; pseudocysts about as long as broad; heterocysts few and distant. Sheath varying greatly in width, pale yellow, ultimately brown. Trichome often projecting a long way beyond the sheath. Floating on moor-pools, or attached to aquatic vegetation. Under this species Bornet and Flahault include *T. flaccida* Ktz., *T. muscicola* Ktz., *T. coactilis* Ktz., *T. pulchra* Ktz., *T. ægagropila* Rbh., and others.

Nostocaceæ.

Aphazinomenon flos-aquæ Ralfs, H.
Cylindrospermum macrospermum Ktz., H.
Nodularia sp., H.

A species of this chiefly brackish-water genus was seen occasionally in bog-pools in the New Forest; but, as neither spores nor heterocysts were observed, specific determination was impossible.

Pediastreæ.

Pediastrum Boryanum Turp., H.
" rotula A. Br., H.
Staurogeneis rectangularis A. Br., H. Fig. 5.

This rare organism was only very seldom seen in a gathering from a pool near Beaulieu. Of its systematic position I am very doubtful. It seems to me not improbable that it may be an early stage of a *Pediastrum*, and it is placed near this genus by Braun, but his description (Alg. Unicell., p. 70) is very imperfect. It bears some resemblance to *Merismopedia*, but the colour of the endochrome is chlorophyll-green, not blue-green. It agrees fairly well with Cooke's description ('Freshwater Algæ,' i. p. 46, pl. xviii. f. 3); but the cœnobe is certainly not "cubical." The colony is tabular, like that of *Pediastrum*, about 110 × 75 μ, elliptical with truncated ends, and contains, in the specimens observed, sixteen pseudocysts, arranged in four subfamilies of four each, the whole inclosed in hyaline jelly. The pseudocysts are oblong and somewhat curved, or bean-shaped, about 20–22·5 × 10 μ. It was first observed in these islands by Archer, but he gives no locality; the only British habitat yet recorded of which I am aware is by Marquand, near the Land's End, Cornwall.

Pandorineæ.

Eudorina elegans Ehrb., H.
Gonium pectorale Müll., H, D.

ULOTRICHACEÆ.

Ulothrix zonata Ktz., H, D.

CONFERVACEÆ.

Draparnaldia glomerata Ag., H.
Stigeoclonium protensum Ktz., H.

Filament somewhat moniliform, about 12·5 μ broad in its broadest part; cells rather longer than broad, and slightly constricted at the septa in the lower part of the filament; those towards the apex of the branches much longer. Each branch terminating in a hyaline filament of very great length, as much as 380 μ, septated at long intervals; the branches themselves sometimes again branching. Small stream near Lyndhurst.

RHIZOCLONIUM GEMINATUM n. sp., H. Figs. 6, 7.

Filaments long, slender, curving and interlaced; cells about 20 × 12·5 μ, with very thin cell-walls. From the filaments are put out here and there short root-like processes filled with green endochrome; these are sometimes solitary, but more often two proceed from adjacent cells, or even two from the same cell; and these are then curved and interlace with those of an adjoining filament, but without any actual conjugation. A ball of flocculent matter commonly collects round these protuberances, firmly welding the filaments together. Forming, with the preceding, a flocculent scum on a small slow stream near Lyndhurst. Most of the species of the genus grow in brackish water.

DESMIDIACEÆ.

Hyalotheca dissiliens Sm., H.
„ mucosa Ehrb., H.
Desmidium Swartzii Ralfs, H.
Docidium Ehrenbergii Ralfs, H.
Cylindrocystis diplospora Lund., H, D.
* „ crassa DBy., H.
Penium cylindrus Ehrb., H.
„ digitus Ehrb., H, D.
„ closterioides Ralfs, H, D.
„ Brebissonii Ralfs, H, D.
„ didymocarpum Lund., D.
Tetmemorus Brebissonii Men., H, D.
„ granulatus Bréb., H.
„ lævis Ralfs, H, D.
Spirotænia condensata Bréb., H, D.

Closterium didymotocum Cord., H, D.
„ lunula Ehrb., H.
„ turgidum Ehrb., H.
„ Ehrenbergii Men., D.
„ Dianæ Ehrb., H, D.
„ angustatum Ktz., H, D.
„ rostratum Ehrb., H.
„ setaceum Ehrb., H, D.
* „ *Kützingii* Bréb., H.

Although given in Cooke's 'British Desmids,' no locality is recorded for this species.

Closterium intermedium Ralfs, D.
„ cornu Ehrb., H.
„ acutum Bréb., H.
„ aciculare West, D.
„ linea Pert., H.
Micrasterias denticulata Bréb., H, D.
„ „ var. INTERMEDIA n. var., D. Fig. 8.

Length of frond about 200 μ, breadth about 180 μ. This variety appears to be intermediate between *M. denticulata* Bréb. and *M. Thomasiana* Arch. The size and the segmenting correspond closely to those of the typical form, the dentation of the edge being decidedly more apiculate, resembling that of *M. Thomasiana;* but it is destitute of the "apiculate elevations" and remarkable "divergent projections" in the centre described as characteristic of this species. It is, however, very doubtful whether *M. Thomasiana* should be retained as a distinct species. Its extreme form appears to have been seen by no one but its discoverer. Jacobsen (Desm. Denm., in Bot. Tidskr., 1874, p. 186) regards it as a variety of *M. denticulata,* and describes a series of intermediate forms with the projections more or less developed. The present variety occurred in bog-pools on Dartmoor.

Micrasterias rotata Ralfs, H, D.
„ „ var. URNIGERA n. var., H. Fig. 9.

This beautiful desmid differs from the typical form in its larger size, and in the urn-like form of its central lobe, which projects as much as 25 μ beyond the lateral ones. In this respect it resembles Ralfs's draw ng more nearly than Cooke's. Wolle (Desmids U.S., pl. xxiv. f. 1) also depicts the central lobe as projecting considerably. The surface of the frond is covered with inflated protuberances. The extreme length, including the projection, is 325 μ, the greatest breadth 250 μ; but in the specimens observed the two halves were of very unequal size. Bog near Lyndhurst.

Micrasterias papillifera Bréb., H.
„ truncata Bréb., H.
„ „ Bréb. var. TRIDENTATA n. var., H. Fig. 10.

A variety with the lateral lobes tridentate instead of bidentate.

Micrasterias crenata Bréb., H, D. Figs. 11, 12.

Two forms of this variable species. De Wildeman has shown (Bull. Roy. Soc. Belg., 1888; Obs. sur quelques Desm., p. 2) how closely this species is linked with the preceding by intermediate forms.

Micrasterias crux-melitensis Men., H. Fig. 13.

The form observed (but only very rarely) of this rare and beautiful desmid in the New Forest bears a much closer resemblance to that which occurs in America (Wolle, Desm. U.S., t. xxxv. f. 3) than to any hitherto recorded from Great Britain, the lobing not being nearly so deep. The outline of the frond is very nearly circular, about 140 μ in length and breadth; its surface is covered with small protuberances. The species has been gathered hitherto, in the south of England, as far as I am aware, only by Jenner.

Euastrum oblongum Grev., H.
„ crassum Ktz., H, D.
„ CRASSO-HUMEROSUM n. var., D. Fig. 14.

This interesting variety or possible hybrid is described at length elsewhere ('Annals of Botany,' vol. iv. p. 171).

*Euastrum pinnatum Ralfs, H.
„ humerosum Ralfs, H, D.
* „ ventricosum Lund., D.
„ affine Ralfs, D.
„ ampullaceum Ralfs, D.
„ insigne Hass., D.
„ didelta Ralfs, H, D.
„ cuneatum Jenn., H.
„ ansatum Ralfs, H, D.
„ circulare Hass., H, D.
„ pectinatum Bréb,, H, D.
„ rostratum Ralfs, H.
„ binale Ralfs, H.
* „ erosum Lund., H, D.
* „ ornithocephalum Benn., H.
Cosmarium quadratum Ralfs, D.
* „ homalodermum Nordst., D. Fig. 15.

Nearly circular in outline; length and greatest breadth about 70 μ; two conspicuous protuberances on each half-cell. Bog-pools,

Dartmoor. No locality is given in Cooke's 'Brit. Fresh-water Algæ,' but Mr. West has gathered it in Yorkshire.

Cosmarium cucumis Cord., H, D.
,, Ralfsii Bréb., H, D.
* ,, pachydermum Lund., D.
,, pyramidatum Bréb., H, D.
,, pseudo-pyramidatum Lund., H.
,, Brebissonii Men., H, D.
,, margaritiferum Men., H.
,, botrytis Men., H, D.
* ,, præmorsum Bréb., H.
* ,, ochthodes Nordst., H.
,, ornatum Ralfs, H.
,, Broomei Thw., H.

This is certainly a true freshwater species.

Cosmarium speciosum Lund., H.
* ,, *prægrande* Lund., H.

See Note at the end of this paper.

*Cosmarium globosum Buln., H, D.
,, cucurbita Bréb., H.
,, attenuatum Bréb., D.
,, turgidum Bréb., H.
Xanthidium armatum Bréb., H, D.
,, aculeatum Ehrb., H.
Arthrodesmus incus Hass., H.
Staurastrum cuspidatum Bréb., D.
,, avicula, Bréb., H.
,, Reinschii Roy, D.
,, hirsutum Bréb., H.
,, teliferum Ralfs, H, D.
,, Pringsheimii Reinsch, H, D.

This appears to be a widely distributed species.

Staurastrum spongiosum Bréb., H.
,, muticum Bréb., H, D.
,, alternans Bréb., H.
,, polymorphum Bréb., H.
,, proboscideum Arch., H.

Zygnemaceæ.

Spirogyra longata Vauch., H.

Seen in lateral conjugation.

Spirogyra porticalis Vauch., H.

MESOCARPACEÆ.

Mesocarpus pleurocarpus DBy., H.
Staurospermum gracillimum Hass., Beaulieu, H.

SIPHONEÆ.

Vaucheria sessilis Vauch. Wet rock, Buckfastleigh, D.

NOTE.

I have to add a few words in reference to my previous papers of this series.

Nostoc hyalinum mihi (Journ. R. Micr. Soc., 1886, p. 4, pl. i. figs. 2, 3). Bornet and Flahault point out that this specific name has already been appropriated by Rœmer. I propose, therefore, that it shall in future be known as *N. opalinum* Benn. Those eminent algologists think that my species, if distinct, is most nearly allied to *N. microscopicum* Carm.

Xanthidium spinulosum mihi, tom. cit., p. 10, pl. ii. f. 17. I am now convinced that the peculiarities on which I founded this species are due merely to a peculiar condition of the gelatinous envelope, and that it is simply a form of *X. fasciculatum* Ehrb. The name should therefore be abolished.

Oscillaria princeps Vauch., op. cit., 1887, p. 11, pl. iv. f. 4. On the (negative) authority of Cooke's 'British Freshwater Algæ,' this species was recorded as new to Britain. Marquand had, however, previously observed it in Cornwall (Trans. Penzance Nat. Hist. Soc., 1885–6); and Mr. Roy informs me that he had gathered it earlier than that in three or four places on Deeside, Scotland. It is probably not uncommon, at all events in the southern counties.

Apiocystis Brauniana Näg., tom. cit., p. 9, pl. iii. f. 1. This has been long known in Aberdeen, according to Roy (*in litt.*). Mr. S. Le M. Moore has also found it in this country, and has been more successful than previous observers in detecting its mode of reproduction (Journ. Linn. Soc., vol. xxv. p. 362). Mr. West also records it from Yorkshire.

Aphanothece microscopica Näg., tom. cit., p. 10, pl. iii. f. 3. Has been familiar to Mr. Roy for many years in the neighbourhood of Aberdeen.

Pediastrum integrum Näg., tom. cit., p. 12, pl. iv. figs. 11–13. Occurs in the neighbourhood of Aberdeen, according to Mr. Roy, but is rather uncommon.

Cœlastrum cubicum Näg., tom. cit., p. 13, pl. iv. f. 14. Has been gathered repeatedly by Mr. Roy in the neighbourhood of Aberdeen. He records also *C. microsporum* Näg. from the same locality, and Mr. West adds a Yorkshire habitat.

Cosmarium sphericum mihi, tom. cit., p. 17, pl. iv. f. 22. This

appears to be identical with *C. prægrande* Lund., Desm. Suec., p. 54, pl. iii. f. 21. I have observed it in Cumberland, Cornwall, and Hampshire.

Zygnema peliosporum Wittr. was omitted from my list of species from North Cornwall, where it is not uncommon in bog-pools. I am not aware of its having before been gathered in these islands, except by Marquand in West Cornwall. It is not given in Cooke.

Homospora mutabilis Bréb., op. cit., 1888, p. 2, pl. i. f. 1. Has also been observed by Marquand in Cornwall.

Acanthococcus anglicus mihi, tom. cit., p. 2, pl. i. f. 4. De Toni having pointed out that the name *Acanthococcus*, given to this genus by Reinsch, had been previously appropriated to a genus of Florideæ, and proposed the substitute *Glochiococcus*, this species must now be known as *Glochiococcus anglicus* (De Ton.) Benn.

II.—*On an Objective with an Aperture of* 1·60 *N.A.* (*Monobromide of Naphthaline Immersion*) *made according to the Formulæ of Prof. Abbe in the Optical Factory of Carl Zeiss.*

By Dr. S. Czapski (Jena).

(*Read* 11*th December*, 1889.)

An advance in the increase of the capabilities of an optical instrument is always possible in two directions—the *qualitative* and the *quantitative.* The first point Prof. Abbe has kept in view, as far as the Microscope is concerned, in the construction of the apochromatic objectives. The quality of the objective was here augmented by a complete union of the rays, without that element on which the capacity of the objective primarily depends, viz. the aperture, being sensibly increased. In the terminology of optics it was properly only the "definition" of the objective which was improved. That by this means its resolving power was also increased was an indirect consequence of the first condition. For it is natural that an objective of given aperture should only have the resolving power prescribed by theory, if the assumption of this theory—perfect union of rays—is fulfilled. The earlier known achromatic objectives did not therefore reach the limit of the resolving power which the aperture allowed them; the apochromatics approach extraordinarily near to this limit. This aperture itself, however, in the case of the strongest apochromatics, was not essentially greater than that which had been already obtained by Zeiss, as well as by other opticians, in their earlier objectives (1·40 against 1·30 of the earlier).

An advance upon that attainable with the apochromatics of 1886 is only possible if the aperture is increased in a marked degree. To this advance a special difficulty opposes itself. In order to reach a given aperture a, for instance 1·60, it is necessary that all media between the object and the front lens of the objective, as well as this lens itself, should have a higher refractive index than a, therefore higher than 1·60 in the case we are supposing. For since the angle of aperture of the rays entering into the objective can practically scarcely exceed 150° (as cover-glass and focus necessitate a certain distance of the object from the front lens), therefore, since $a = n \sin u$, must $n > a$, because $\sin u$ is necessarily < 1; and between the object and front lens there must be no layer of a medium, however thin, whose index n' is $< a$. For at such a layer the part of the incident pencil whose aperture is n' would, according to the laws of geometrical optics, be lost by total reflection, and there would remain only the part whose aperture a' is $< n'$.

At the present time, however, not only do the front lenses of objectives consist for the most part of crown glass with a maximum index

1·56, but the cover-glasses are made of a crown-glass (blown) whose index is about 1·52, and the index of the immersion liquid is equally about 1·52. If, then, we are confined to the use of these materials, no higher aperture is attainable than 1·45 N.A. as a maximum, as is also proved practically. If it is desired to go beyond this limit, then, as shown above, care must be taken that the substances used for cover-glass, front lens, and immersion liquid have indices higher than the desired aperture.

The aperture which was first decided upon, and which was completely realized, was 1·60. An immersion liquid which satisfied the required conditions was found in monobromide of naphthaline, whose index is about 1·66. For the cover-glass and the front lens was selected for reasons of construction (removal of spherical and chromatic aberration) a flint-glass of index 1·72, so that the objective was no longer, in the strict sense of the term, a homogeneous-immersion objective. None of the existing kinds of flint glass appeared to be suitable for the front lens. Special fusions had to be undertaken (by Dr. Schott) in order to obtain a satisfactory glass.

The work of calculation for establishing a suitable formula had been going on for a year previously, but was not brought to an end until August of this year. In the course of the calculation the favourable result was obtained, that in spite of the very difficult conditions, not only could the removal of the chromatic and spherical aberration in the ordinary sense be obtained, but in addition a correction of almost the same perfection as with the apochromatics.

In the beginning of September the first objectives were completed. One was exhibited by the author to the Naturforscherversammlung in Heidelberg, from September 18–24, in the exhibition of newly constructed scientific instruments, as well as in the section for pathological anatomy. The other was placed at the disposal of Dr. van Heurck, of Antwerp, who had done excellent service for the perfecting of the objectives, in preparing new test-objects indispensable for their testing and final adjustment. As already mentioned, the objects must have special cover-glasses of flint glass. There must not be between cover-glass and object any medium whose index $< 1·66$. Thus, the preparation must either be melted on the cover-glass (which does not succeed with flint-glass) or it must be imbedded in a medium whose index is at least = 1·66.

For the visibility of microscopic objects it is, however, well known to be advantageous if they are placed in a medium whose index differs as much as possible from that of the object itself. In the present case it is important that that index should be as *high* as possible, since the index of the diatom valve is scarcely higher than 1·55. How Dr. van Heurck in numerous readily arranged experiments overcame this double difficulty, and how he has been successful in finding a practical medium of index 2·4, I must leave to him to explain.

A third and fourth difficulty for certain purposes also lie in the following:—If it is desired to use the most oblique illumination which the objective will allow, the same remarks are equally applicable to the incident pencils as to those proceeding from the object; its aperture will not have its full value, if between object and condenser there is a medium whose index is less than the figure which represents the aperture, and the condenser itself must be so constructed that it also shall have the full aperture desired. In other words, the slide must also consist of flint glass of $n > 1 \cdot 65$, and between it and the condenser must be interposed a medium of $n > 1 \cdot 65$, and the front lens of the condenser must in all cases be made of flint glass of at least the same n.

A condenser of this character was constructed at the same time as the objective; also slides of flint-glass, and between them and the condenser monobromide of naphthaline was used, just as between cover-glass and objective. This arrangement, as above said, is only necessary with preparations for which the most oblique illumination possible is required—as, for example, *Amphipleura pellucida*, or those which are to be observed with *completely* open illuminating cone. In all other cases, including axial illumination, ordinary slides of crown glass and the ordinary condensers suffice. According to the aperture of the latter, and according as a stratum of air is left between it and the stage, or water or oil is added, we obtain even in these cases an illuminating cone of an obliquity representing an aperture of 1·0–1·4. For most purposes the latter is quite sufficient.

The type of construction of the objective is the same as that of the other apochromatic objectives of large aperture. To the more than hemispherical front lens of flint glass (index 1·72) succeeds a binary achromatic lens. Over this lower part is the (for apochromatics) characteristic upper part of the objective, on the peculiar composition of which depends the removal of the chromatic difference of the spherical aberration, i. e. first a single lens of crown and following on this two more achromatic lenses, the one composed of two and the other of three lenses. The focal length of the objective is 2·5 mm. (1/10 in.).

Since the objective, as already pointed out, is not really a homogeneous-immersion one (cover-glass and front lens having an index of 1·72, whilst the immersion liquid has an index of 1·66) and also because of the extraordinarily large aperture of the image-forming rays, it is exceedingly sensitive to changes of the cover-glass thickness, and also to every change in the index of the immersion liquid—almost as sensitive as a high-power dry system. It must therefore be used only with pure monobromide of naphthaline and with cover-glasses of the same thickness for which it is corrected, if the image is to be perfect. The cover-glasses themselves moreover must be made with great care and of the right glass.

The production of these cover-glasses in the usual way—by blow-

ing in a furnace—was forbidden by their substance. The condition mentioned above, however, made it necessary to bring the cover-glasses to the required thickness by carefully grinding down somewhat thicker plates to 0·01 to 0·02 mm., and to polish them with care (like lenses of medium quality), which naturally makes such cover-glasses very expensive.

This is not the place to dilate on what can be done with objectives of this kind. The results which Dr. van Heurck has already obtained in the use of them lead in any case to the hope that, in spite of the great difficulty of their use, they will afford valuable aid for certain problems of microscopy. It will be a question for connoisseurs to decide, whether in other branches of microscopical research besides that of diatoms (more especially cultivated by him) an equally marked advance on that previously reached can be obtained.

The inquiry may be made whether and how far a further increase of the aperture beyond that of 1·60 here attained can be expected. The difficulty of such a construction consists (as was the special hindrance before) in the *want of a suitable immersion liquid.* This liquid must have an index of at least 1·8–1·9 (in order to make an essential advance on the present objective), and it must besides possess those general properties which qualify it as an immersion liquid: i. e. not to attack the glass of either the cover or the front lens; sufficiently transparent; not too viscous; not inflammable (like the phosphorus solutions), &c. If such a liquid were found, Professor Abbe would be at once prepared to undertake the calculation of an objective of an aperture of 1·8 or 1·9, since glass of sufficiently high index for the front lens and the cover-glass could be provided without difficulty.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Theories of Heredity.‡—Mr. E. B. Poulton gives a sketch of the theories of heredity propounded by Mr. Darwin and Prof. Weismann. He points out that the direct evidence in favour of the transmission of acquired characters seems to fail to stand the ordeal of a thorough investigation, and he urges reasons against the chief lines of indirect evidence. These lines are the fact of individual variation, the effects of use and disuse of parts, and the facts presented by the phenomena of instinct. The consideration of twins and monstrosities leads to the conclusion that individual variation is predetermined in the fertilized ovum. Weismann contends that the object of sexual reproduction is to supply variations upon which natural selection can operate. The apparent effects of increased use are more probably due to the operation of natural selection upon a part which is, *ex hypothesi*, of especial importance, combined with the admitted increase which follows increased use during the life of the individual. The apparent effects of disuse are more probably due to the cessation of natural selection, which can no longer maintain the efficiency of a useless part. The phenomena of instinct seem capable of explanation by the operation of natural selection upon blastogenic variations of the nervous system rather than by the supposed transmission of acquired habit.

Intracellular Pangenesis.§—Herr H. de Vries seeks to rehabilitate the theory of pangenesis, so far as that credits the germ-cell with an accumulation of minute elements corresponding to the characteristics of the organism. The author's "pangenes" are not so small as Haeckel's

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Midland Natural., xii. (1889) pp. 245–58.

§ 'Intrazellulare Pangenesis,' Jena, 1889. Biol. Centralbl., ix. (1889) pp. 545–50

"plastidules," nor so large and like one another as Spencer supposed his "physiological units" to be; in size they are nearer to the smallest known organisms than to molecules, and they are as diverse as the characteristics of the organism are numerous. De Vries recognizes regular successions of cells "from the fertilized egg-cell through the individual to the following generation," and distinguishes primary and secondary courses or tracks, of which the former run direct from germ-cell to germ-cell, while the latter are circuitous, giving the organism in many cases the power of asexual multiplication. The products of cell-division may be both on the germinal track (phylotic), or both in the body proper (somatic), or one may be germinal while the other is somatic (somatarchic). The author does not allow the legitimacy of a hard and fast distinction between somatic and germinal cells.

According to the theory of "intracellular pangenesis," the entire protoplasm is made up of "pangenes." Each characteristic of the organism has its special "pangene." Representatives of all are found in the nuclei, while the body of the cell contains for the most part only those which are essential to that cell's activity. So many remain within the nucleus, and are active, for instance, in nuclear division; so many must pass out into the protoplasm of the cell to unite with other "pangenes," to multiply, and become active. The theory seeks to combine one of the fundamental ideas of Darwin's pangenesis with the more modern conception of germinal continuity.

Theory of the Mesoderm.*—Prof. C. Rabl has been led by his investigations on the segments of the Vertebrate head to consider the great problem of the formation and differentiation of the mesoderm. His researches refer chiefly to embryos of *Pristiurus*, fowl and pigeon, and rabbit.

I. *The Formation of the Mesoderm.*—(*a*) Rabl's investigation of Selachian development leads to results essentially the same as Rückert's. That portion of the mesoderm which has its origin beside the chordal endoderm Rabl distinguishes as *gastral*, while that which arises from the endoderm of the invagination-margin is distinguished as *peristomial*, corresponding respectively to Rückert's axial and peripheral mesoblast. The two portions pass into one another at the posterior end of the embryonic rudiment. It is noteworthy that the peristomial mesoderm retains its connection with the endoderm longer than the gastral does. (*b*) In the mesoderm of the chick-embryo at the end of the first day two portions are to be distinguished, that which arises from the head-process and that from the primitive streak. The two pass into one another at the anterior end of the streak. Except in the head-process and in the primitive streak there is never any connection between the mesoderm and the primary layers; at the periphery the mesoderm stops with a sharp margin between ectoderm and endoderm. Rabl's results are for the most part in accord with the well-known study of the germinal layers of the chick by Balfour and Deighton. (*c*) The author's investigation of the blastoderm of the rabbit was less satisfactory, but his results seem to corroborate van Beneden's conclusion that one portion of the mesoderm arises in the form of two symmetrical rudiments—

* Morphol. Jahrb., xv. (1889) pp. 113–252 (4 pls.).

right and left—from the margins of the head-process, while the other and principal portion originates from the posterior end and from the margins of the primitive streak.

The memoir becomes more interesting as the author proceeds to discuss how the formation of mesoderm in Amniota is to be derived from that of Anamnia, and that again from such a mode as *Amphioxus* exhibits. Rabl has a good deal to say about the yolk, and expounds most lucidly his theory of its repeated acquisition and loss throughout the history of Vertebrates. The eggs of *Amphioxus* and the Cyclostomata are primarily poor in yolk; the poverty is also true of Ganoids and Amphibians, but here it is secondary; while in placental mammals it is tertiary. Similarly the eggs of Elasmobranchs are primarily rich in yolk, while those of Teleosteans, Sauropsida, and Monotremes are only secondarily so. Having discussed the yolk, the author seeks to connect the various forms of gastrulation, and points out in so doing that the yolk of the Protamniota ought naturally to be situated where the principal mass lay in their amphibian ancestors, viz. in front of and ventral to the blastopore. He is led to the opinion so often expressed that the primitive groove of Amniota represents the blastopore, and the primitive streak its coalesced margins. The dorsal margin of the blastopore in *Amphioxus*, Cyclostomata, and Amphibia, the posterior margin of the blastopore in Elasmobranchs, Ganoids, and Teleosteans, and the anterior end of the primitive groove of Amniota are all homologous. The same is true of the ventral margin of the blastopore in *Amphioxus*, Cyclostomata, and Amphibians, the anterior margin in Elasmobranchs, Ganoids, and Teleosteans, and the posterior end of the primitive groove of Amniota. Rabl supports this conclusion by arguments drawn from the nature of the segmentation, the formation of the mesoderm, the origin of the neurenteric canal, and the formation of the blood. In the course of his argument he urges that the metamerism of the Vertebrate body has its origin always from the gastral, never from the peristomial mesoderm, and also that a vertebral segment always arises *behind* a vertebral segment, the first one appearing without exception behind the position at which the auditory vesicle is formed.

Rabl then passes to consider the homology of the mesoderm in the Bilateralia. His general conclusion is that in all Invertebrate Bilateralia the mesoderm has its origin from two rudiments separated in the median line and derived from the endoderm of the blastopore margin. He makes an exception, however, on behalf of the Chætognatha. Having gained the above general result, Rabl proceeds to show that a perfect homology obtains between the mesoderm of the Invertebrate Bilateralia and that of Vertebrates. On questions of detail, he inclines to believe that the mesoderm had its phylogenetic origin in two endoderm cells symmetrically situated by the margin of the blastopore, and along with Hatschek still suggests that the primary function of these cells was reproductive.

II. *The Differentiation of the Mesoderm.* One general conclusion stands out among the rest. The head of Vertebrates is regarded as consisting of two portions—an anterior, larger, unsegmented region, and a posterior, smaller, segmented part. This is true both ontogenetically

and phylogenetically. The boundary between the two regions is marked by the auditory vesicle, which is reckoned, however, with the anterior portion. The mesoderm of the anterior head may be divided into several portions, but these are not comparable to vertebral segments (*Urwirbel*) either in origin or in differentiation. In the anterior head there are (apart from olfactory and optic) two primary nerves, the Trigeminus and the Acusticofacialis. The nerves of the eye-muscles are perhaps to be derived from the Trigeminus, and the muscles themselves perhaps from the visceral musculature associated with the first arch. The primary nerves of the posterior head are the Glossopharyngeus and the Vagus; the Hypoglossus also arises from the ventral roots of this region. A portion of the Vagus may also attain independence as the Accessorius. Homologues of dorsal branches are not to be sought for, since they arise in the trunk at a late stage, apparently in connection with the splitting of the originally single lateral muscular mass into dorsal and ventral regions. The unsegmented mesoderm of the anterior head of Craniota is compared to the process of the first vertebral segment in *Amphioxus*, as described by Hatschek.

Placenta of Rodentia.*—M. M. Duval commences his account of his own observations with a description of the placenta of the Rabbit. For the terms plasmodiblast or cytoblast, suggested by Van Beneden for the part formed from the ectoderm of the egg, he proposes the *vox hybrida* ectoplacenta. On the seventh day of gestation, that is just before the fixation of the ovum to the mucous membrane, the latter exhibits the modifications by which the maternal placenta is distinguished; these are, macroscopically, the formation of the two cotyledonary projections, which are separated by a wide and deep intercotyledonary groove; the histological appearances are the conversion of the uterine epithelium into a homogeneous layer, and the development of the capillaries of the mucous membrane.

The development of the fœtal part of the placenta commences at the end of the seventh day with an ectodermal thickening in the form of ectoplacental crosses. In these there are a number of layers, the superficial of which form the plasmodial layer of the ectoplacenta, while the deeper remain formed of distinct cells. In the former the nuclei multiply by direct division, in the latter by karyokinesis. The former increases by outgrowths which make their way into the mucous membrane of the cotyledonary projections of the uterus; at the end of the ninth day they more or less completely surround the superficial capillaries of this mucous membrane. At the same time every trace of the epithelium of the uterus disappears at the level of the ectoplacental formation, and there only remain glandular cæca.

After the ninth day the elements of the plasmodial layer of the ectoplacenta surround the superficial capillaries of the uterine cotyledons, and, owing to the disappearance of the endothelial wall which alone limited these vessels, they become reduced to mere sinuses hollowed out in the substance of the ectoplacenta, that is to say, to sinuses bounded by the ectodermal elements of the embryo and filled with maternal blood.

* Journ. Anat. et Physiol., xxv. (1889) pp. 309-42 (2 pls.).

Nomenclature of Sexual Organs in Plants and Animals.*—Prof. T. Jeffery Parker offers some criticisms on Mr. R. J. Harvey Gibson's essay "On the Terminology of the Reproductive Organs of Plants." He would retain the terms gonad (= reproductive organ), gamete (= conjugating body), and zygote (= product of conjugation), and use the terms spermary and ovary for the differentiated male and female gonads, sperm and ovum for male and female gametes, zygospore for a resting cell or non-motile zygote formed by the conjugation of equal and similar gametes; zygoöspore for a similarly formed motile zygote and oosperm for a zygote formed by the union of ovum and sperm.

Prof. Parker gives a useful table in which are classified the chief methods of sexual reproduction, but of which we have only space for the larger divisions.

A. Union temporary, probably accompanied by an exchange of nuclear material, and followed by increased activity in fissive multiplication; gametes equal and similar and coextensive with the conjugating organisms.

e. g. *Paramæcium.*

B. Union permanent, resulting in the formation of a zygote, the nucleus of which is (? always) formed by the fusion of the nuclei of the two gametes.

I. Gametes equal and similar.

e. g. *Dallingeria*, *Protococcus*, et al.

II. Gametes equal in size, but one (ovum or egg-cell) is either altogether non-motile or becomes so before conjugation, while the other (sperm or sperm-cell) is motile.

e. g. *Spirogyra*, *Ectocarpus.*

III. Gametes dissimilar both in form and size, one, the microgamete, being relatively small and active; the other, a macrogamete, relatively large and passive.

e. g. *Vorticella*, *Volvox*, *Fucus*, *Metazoa*, *Phanerogams.*

Egg-capsule of Chimæra monstrosa.†—Dr. A. Günther gives a description of the egg-capsule of *Chimæra monstrosa*; it was dredged by the Rev. W. S. Green last July in 315 fathoms off the south-west coast of Ireland, and is of especial interest since the egg-capsule described by J. Müller and by Duméril as that of *Chimæra* is that of *Callorhynchus.* It is 6½ in. long, broad anteriorly, and gradually tapers into a styliform posterior portion for the tail of the embryo; this styliform process is provided with four narrow ridges of which the strongest is that on the right side; the dorsal and ventral ridges are thinner, fragile, and show a rayed structure. Dr. Günther has already suggested that *Chimæra* most probably propagates in deep water; the capsule has no filaments for adhesion, and these would be useless at a depth where the water is perfectly quiet.

γ. General.

Index to the 'Zoologischer Anzeiger.'‡—Prof. J. V. Carus has issued a very elaborate, and apparently complete, though by no means

* Proc. Australasian Assoc. Adv. Sci., 1888, pp. 338–43.
† Ann. and Mag. Nat. Hist., iv. (1889) pp. 415–7.
‡ Leipzig (Engelmann), 8vo, 1889, iv. and 444 pp.

aultlessly printed, index to the first ten volumes of his 'Zoologischer Anzeiger.' This volume will be of great service not only to the possessors of these volumes, but to all students of zoology, for it is a guide to the literature of the science during an important decade.

Zoology of Mergui Archipelago.—The descriptions of the collections made by Dr. John Anderson in the Mergui Archipelago are now complete; their publication has extended over three years, and they occupy volumes xxi. and xxii. of the Journal of the Linnean Society.

B. INVERTEBRATA.

Medullated Nerve-fibres and Neurochord in Crustacea and Annelids.*—Herr B. Friedlaender has made a special examination of the neurochord of *Mastobranchus;* he finds that its sheath consists at least largely of a substance which is very like the medulla of vertebrate nerve-fibres. Within the neurochord there is a substance which is coagulated by alcohol, sublimate, heating and so on, which appears to be of a plasmatic nature, but does not seem to have any definite structure. This substance is the direct continuation of the processes of the neurochord-cells, and appears to agree with them completely.

The neurochords of *Mastobranchus* are three in number, are tubular in form and divisible into sheath and contents; the former consists largely of (in Pertik's nomenclature) myelinogenous or nerve-medulla-like substance; it is probable that there is also a supporting substance, but this cannot be definitely affirmed.

A comparison of a number of apparently similar structures seems to show that the so-called neurochords of *Mastobranchus*, *Lumbricus*, and probably of other Annelids, the nerve-tubes of *Palæmon*, *Squilla*, and very probably of other Crustacea and perhaps of Arthropods in general, and the medullated fibres of Vertebrates are, fundamentally, the same structures. They are all tubular and consist of wall and contents; when the former is of considerable thickness it appears in optical section to have a double contour. The wall of these tubes appears in many (? all) cases to consist at least partially of myelinogenous substances which exhibit certain differences in some cases. Many authors have erroneously regarded the "myelin formations" to which they give rise as part of the contents of the tubes. The contents of the tubes is a protoplasmic substance, rich in water, and directly continuous with the processes of the ganglionic tubes. Among Vertebrates these contents are called axis-cylinders, a name which may be given a wider and more general extension. On the whole, we may conclude that the so-called neurochords are medullated nerve-fibres, and deny the truth of the general proposition that medullated nerve-fibres are found in Vertebrates only.

In conclusion, the author considers the function of the neurochords; he is inclined to doubt that of their being an organ of support. With some diffidence he is inclined to associate them with the power possessed by a number of Annelids and Crustacea of making sudden contractions of the body; in such movements there is an almost simultaneous contraction of the homodynamous muscles of all or nearly all the segments of the body.

* MT. Zool. Stat. Neapel, ix. (1889) pp. 205-65 (1 pl.).

Mollusca.

Mollusca of Canary Islands.*—Prof. C. Chun gives an account of some of the Mollusca collected during a visit to the Canary Islands; as may be supposed he treats mostly of Pteropoda. He gives an account of *Desmopterus papilio* g. et sp. n., Prof. Pelseneer's critical observations on which we have already reported.† *Phyllirhoë trematoides* sp. n. seems to be a well-marked form, of a reddish colour, not so transparent as *P. bucephala*, and smaller than it or *P. atlantica*.

Census of the Molluscan Fauna of Australia.‡—Prof. R. Tate points out that the marine molluscan fauna of Australia admits of division into two sections, one occupying the tropical shores and consisting largely of migrants from the oriental marine province, the other belonging to the temperate waters and consisting largely of endemic species and possessing several restricted genera. The southerly termination of the Great Barrier Reef seems to be a definite point of separation on the east coast. On the west the tropical fauna prevails as far south as Shark Bay, while at Freemantle the Australian species are in the ascendency. The Australian province has yielded 1672 species, of which 72 per cent. are restricted. Others belong to New Zealand or the South Polynesian area, and 13 link temperate Australia with South Africa. The Indo-Australian province has yielded 1495 species, of which rather less than half are endemic in Australia. The author sums up his results in a convenient and easily comprehended table. One genus of Cephalopoda, nine of Gastropoda, and six of Conchifera, are peculiar to Australia. The terrestrial Mollusca are in their species locally distributed, but the genera are nearly all widely dispersed over warm and temperate regions. Of a total of 461 species only two are extra-Australian.

γ. Gastropoda.

Some Species of Vaginula.§—Dr. H. Simroth has a preliminary notice of his studies on some species of *Vaginula*, all of which are new and are called *V. Leydigi* (from Queensland), *V. Hedleyi* (from Queensland), and *V. Hennigi* (from Cambodja). In the first of these the most anterior lobes of the liver lie in front of the intestine, in the others behind. The salivary glands of *V. Hedleyi* consist of a number of separate, flat, whitish saccules, in *Leydigi* they are compact and brownish. The differences in the generative organs are next described. The pedal gland of all is a loose tube, which agrees generally with that of *Testacella* and *Amalia*, but exhibits very great differences in details. The differences are much less marked in the case of the heart, kidney, and lungs. The last differ considerably from the ordinary respiratory organ of the Pulmonata; the respiratory surface is not provided for by vascular trunks which branch more or less finely, but by sinuous longitudinal folds, which partly break up the pulmonary space into chambers, and by other finer folds and coils which provide the necessary extensive surface.

* SB. K. Preuss. Akad. Wiss. Berlin, 1889, pp. 539–47 (4 figs.).
† See this Journal, 1889, p. 734.
‡ Trans. Roy. Soc. South Australia, xi. (1889) pp. 70–81.
§ Zool. Anzeig., xii. (1889) pp. 551–6, 574–8.

The nervous system is remarkable for the fact that the two strong cords which pass backwards contain the intestinal as well as the pedal nerves; the course taken by them is not the same in *V. Leydigi* and *V. Hedleyi*, but this is on account of the difference in the cephalic aorta and is of no importance. The distribution of the branches seems to the author to show that the whole of the dorsal thickening—the notœum—is equivalent to the mantle, and that the pulmonary and anal orifices primitively lay much further forwards.

The tentacles are solid and cannot be invaginated, and the ommatophores are capable of a considerable amount of forward and backward movement. The smooth knob at the end which carries the eye is enormously supplied with nerves; the stalk is quite different to the ordinary pulmonate type, being extremely fine, with sharply-marked transverse rings; it recalls in a striking way the tentacles of some Auriculaceæ. The surface of the lower antennæ is irregularly papillose, and they have a smooth terminal knob, well supplied with nerves. This knob contains an orifice which leads into a rounded cavity, from the wall of which springs an epithelial cone very rich in nerves. At its base there opens a large multicamerate gland which fills up almost the whole of the tentacle. This organ may be safely regarded as having an olfactory function.

The mucous glands of the skin are no less remarkable, for they are not, as is ordinarily the case, unicellular, but are tubular invaginations of the epithelium, which are lined by pavement-cells, and into which the mucus is emptied from all directions. Differences in arrangement are presented by the different species.

The foot, finally, has its own remarkable characters; the arrangement of the cavernous brain is such that every one of the small solid transverse ridges can be swollen out from behind; the primary vessel has not a constant lumen, but has a number of exceedingly powerful sphincters, which follow one another as closely as the transverse divisions of the foot.

It is clear that the Vaginulidæ are a very remarkable family of the Pulmonata, with a large number of characteristic special adaptations. How these arose we cannot yet say; their affinities to the Helicidæ and their allies are not at all close, nor do they seem to have much to do with the Athoracophoridæ of the Oriental-Australian province. It is most probable that they have a certain though distant affinity with the Auriculaceæ.

Neomenia, Proneomenia, and Chætoderma.*—Mr. G. A. Hansen has some notes on these interesting archaic Molluscs. It was stated by Hubrecht that *Proneomenia Sluiteri* had no penis and no gills, but *P. Sarsii* and *margaritacea* have a penis on either side; this organ appears to be merely a round, hollow tube. As to gills, no such well-developed filamentar branchiæ are seen as in *Neomenia*, but there are true folds with a lumen, in which blood-corpuscles may be detected. The author gives figures of the hinder end of *Neomenia*, which he hopes are more satisfactory than those of Tullberg, and he gives of these a detailed description.

* Bergens Museums Aarsberetning for 1888 (1889) 12 pp. (1 pl.).

In *Proneomenia*, as in *Chætoderma*, the ova pass through the pericardium, whence a canal passes backwards on either side, and opens into the anterior end of the albumen-gland. *Neomenia* is clearly the most highly developed of these three genera in the structure of its generative apparatus.

The various organs of the three forms are briefly compared with one another. The skin of *Chætoderma* is very simple, that of *Proneomenia* gives rise to a thick chitinous cuticle, in which there are spicules, and *Neomenia* has a thick cutis, which is traversed by muscular fibres, nerves, and blood-vessels. The gonad of *Chætoderma* is simple, and the sexes separate; in the others, which are hermaphrodite, the gonad is double. In all three the circulatory organs are arranged in the same way, but the diaphragm is best developed in *Chætoderma;* the blood is red, and the corpuscles oval or rounded cells, with a central nucleus. The author has nothing new to add to the earlier descriptions of the nervous system. The musculature is best developed in *Chætoderma*, which has four strong longitudinal muscles; in that genus also the digestive canal is more highly organized than in the other two.

While *Chætoderma* is by its musculature and skin (saving the calcareous spicules) most like an annelid, in other points of its organization it is more closely allied to the Mollusca. Its large tooth, which must be regarded as a modified radula, its gills and gonads are those of a Mollusc. *Proneomenia* is more distinctly a Mollusc; it has a well-developed radula, is hermaphrodite, and in some species (at any rate) has a penis. In *Neomenia* the molluscan character of the gonads is still more marked, for there is a receptaculum seminis on the efferent duct of the gonad, while the duct appears to be divided. The circulatory system is molluscan, for the blood filters through the tissues; there are distinct blood-vessels in the skin of *Neomenia* only, but these do not seem to have a proper wall.

δ. Lamellibranchiata.

Variability of Tasmanian Unio.*—Mr. R. M. Johnston has made a close study of a number of specimens of the genus *Unio*. He finds that, if specimens marking seven successive stages of growth be compared together, the variations in form from youth to the adult stage embrace characteristics which cover most of the distinctions upon which many of the Australian forms mainly depend for the recognition of distinct specific rank. He thinks it probable that the several forms erected into distinct species in various parts of Australia may ultimately prove to be local varieties or particular stages of growth of one widely distributed species.

Molluscoida.

α. Tunicata.

Development of Pyrosoma.†—Dr. O Seeliger confirms Chun's opinion that the young colonies of four *Pyrosoma*-individuals usually pass from the cloaca of the mother animal to considerable depths,

* Proc. Roy. Soc. Tasmania, 1888 (1889) pp. 95–6 (2 pls.).
† Jenaische Zeitschr. f. Naturwiss., xxiii. (1889) pp. 595–658 (8 pls.).

there multiply asexually, and gradually ascend to the surface. He has been able to work out the life-history with some degree of completeness.

I. The formation of the *stolo prolifer*. The posterior ventral end of a young *Pyrosoma* from an older colony shows three distinct portions which form the bud-generation. There is an ectodermic portion, an endodermic tube or process of the endostyle, and a mesodermic germinal strand, along with a number of mesenchyme cells. In an early stage, the author describes the thickening of the ectoderm, and the origin of the peribranchial tubes from the mesoderm. A further step involves the differentiation of the endodermic tube, and of the mesodermic masses filling the cavity of the stolon. In connection with the mesodermic strand, the peribranchial tubes, the reproductive strand, liberated mesenchyme cells, and the neural canal are described. Seeliger shows the essential agreement between *Pyrosoma* and *Salpa*, as regards the formation of buds, and contrasts this with the very variable processes in other Tunicates. He has previously maintained the phylogenetic independence of the process in the two series.

II. The modification of the *stolo prolifer* into the *Pyrosoma* chain. The stolon grows in length, and divides into distinct regions. In a chain of four or five thus formed, the individuals are still in communication through their pharyngeal and (primary) body-cavities, but as in *Salpæ* the connection is readily broken. The plane of the stolon marked by the primary neural canal and the genital strand corresponds to the median plane of the adult animals. The neural-hæmal axis of each stolon-segment corresponds to the subsequent longitudinal axis, while the longitudinal axis of the stolon and its several segments is the future dorso-ventral axis. This is the result of a marked inequality of growth and consequent displacement in the segments. The ectoderm is of least importance in the differentiation; it produces the cellulose tunic, is pierced by the inhalant and exhalant apertures, and forms long tubular outgrowths which penetrate the mantle as blood-courses. The endoderm divides very early into a proximal and a distal portion, of which the first remains for a while without any essential change, but the second developes into the pharynx and digestive canal of the *Pyrosoma*. This change is described at length. The discussion of the mesoderm begins with an account of the peribranchial tubes. These are at first continuous along the whole of the young stolon, but soon divide into segments corresponding to the buds. They grow especially towards the hæmal surface where their median margins meet below the intestine, and are obliterated to form the cloaca. The appearance of the gill-slits and their relation to the peribranchial chamber are then noticed. The history of the primary neural canal is traced. The persistent ganglion appears far forward on the original neural vesicle from which it soon becomes distinct. The ciliated groove, a sac-like expansion homologous with the "hypophysis-gland" of Ascidians, the first hints of an eye, the disposition of the nerve-strands are discussed in order. Seeliger compares the development of the central nervous system with the very similar process in *Pyrosoma*, and with the development of the true embryos. Some of the free mesoderm cells form blood, while others are fixed as true connective-tissue elements, and form a homogeneous matrix which in old animals fills up the primary body-cavity. Further-

more, in young animals every muscular rudiment consists of a strand of mesenchyme cells, and the author notes that though the muscle round the inhalant aperture has a purely mesenchymatous origin, it exhibits histological characters which the Hertwigs describe as belonging to epithelial or mesoblastic musculature. Finally, heart and pericardium also arise from the mesenchyme. In his account of the history of the genital strand, Seeliger emphasizes the fact that the hermaphrodite apparatus of the organism and the mesoderm of the buds arise from the same rudiment. The memoir concludes with some notes on the formation of the *Pyrosoma* colony.

Heterotrema Sarasinorum.*—Dr. K. Fiedler gives an account of a new genus of Synascidians, which was discovered by the Doctors Sarasin during their visit to Ceylon. It belongs to the family Distomidæ, as defined by Herdman, and stands nearest to *Distoma* itself, but it differs from it in having the efferent orifice merely surrounded by a smooth layer of circular muscles, the teeth being absent; it has also a trifid anal languette, which is wanting in *Distoma*. The author gives a technical account of the new genus and species, as well as numerous details regarding its anatomy.

Arthropoda.

Peculiar Swimming Movements of Blood-corpuscles of Arthropods.†—Dr. H. Dewitz has noticed in certain Arthropods phenomena which led him to believe that the blood-corpuscles are able to swim freely in the blood-fluid. In the hinder wings of a still uncoloured *Tenebrio molitor*, which has just passed the pupal stage, the matrix-tissue of the wings begins to disappear. Processes radiate out from the protoplasm of the cell-body around the nuclei, and pass into the adjoining matrix-cells. This meshwork is filled with blood. The corpuscles are generally narrowed at either end, and sail with one tip directed forward through the meshwork. The author enters into a good deal of detail as to his observations. As to the cause of the movements there is considerable difficulty. No cilia could be detected, nor any regular undulations of the surface, such as Brock has observed in the spermatozoa of a Mollusc; it is possible that they take up and again drive out blood-fluid, and in this way effect their movements. It is clear that the blood-corpuscles of Arthropods have a greater power of movement than those of Vertebrates, for they do not move in a closed vascular system, and can only regain their paths by depending on their own activity. It is not quite certain whether the active movement seen by Max Schultze in the red blood-corpuscles of quite young chicks was a swimming or an amœboid-creeping movement.

Vision of Arthropods.‡—Dr. D. Sharp, after giving an account of Prof. Plateau's valuable experiments on the vision of Arthropods, summarizes his impressions. Insects in motion are guided largely by the direction of light, and the existence of light and shade. When walking they are guided by a combination of light-impressions and tactile-

* Zool. Jahrb., iv. (1889) pp. 857–78 (1 pl.).
† Zool. Anzeig., xii. (1889) pp. 457–64.
‡ Trans. Entomol. Soc. Lond., 1889, pp. 393–408 (1 pl.).

impressions; the latter do not act when the insect is flying. There is not yet any evidence that the light-perceptions are sufficiently complex to be entitled to be called seeing, but, as the large development of the compound eye permits the simultaneous perception of movement, its direction, and of lights and shades over a given area, a dragon-fly may pursue and capture another insect without seeing it in our sense of the word seeing. Dr. Sharp suggests that a set of observations should be made to test to what extent covering the optic organs with pigment is effectual in excluding light from them. It is, further, necessary to observe and delineate the actual tracks made by particular species when escaping from Plateau's labyrinth, the tracks as yet given being only diagrammatic.

α. Insecta.

Distasteful Insects.*—Mr. E. B. Poulton has a somewhat sharp reply to Mr. Butler's observations,† and his only object is to enlighten "readers who may mistake the expression of Mr. Butler's conviction that his notes occupy an altogether unique position for a comprehensive guide to the literature of the subject." To this Mr. A. G. Butler replies ‡ by quoting the observations he communicated to Mr. Poulton some time since. He considers it noteworthy that no insect in any stage excepting the red-tailed humble-bee (which was only offered to the Missel-Thrush) was rejected by all his birds; those insects which were refused by certain species were eagerly devoured by others, so that it was impossible to conclude that any of them enjoyed perfect immunity from destruction. His birds did not learn by experience to reject with scorn that which they had proved to be unpalatable, and in some instances they seemed to acquire a taste for larvæ previously refused. "Birds are very intelligent, but their memories are ridiculously short." As to Mr. Poulton's remark that birds are afraid of large spiders, Mr. Butler points out that the larva of *Stauropus fagi* does not leave the egg full-grown.

Abdominal Appendages of Insects.§—Dr. E. Haase has investigated the abdominal appendages of Insects, and especially of the Thysanura, with especial reference to the affinities of the Myriopoda. He finds it necessary to distinguish between the soft ventral saccules, which can be evaginated, and which are generally known as segmental or crural glands, and the stump-like appendages which he calls "Bauchgriffel."

The ventral saccules of *Scolopendrella* are developed from the third to the eleventh segment of the trunk; it is pointed out that they may be filled with blood, and are drawn in by a special muscle; their cuticle is smooth, has no distinct pores, and the nuclei of their matrix are very large. Among the Diplopoda we find saccules of similar structure, but with a simpler matrix and better developed retractors; they lie in the third pair of legs of both sexes of *Lysiopetalum*, *Polygonium*, and *Siphonophora*. In the Chordeumidæ a few are found between the copulatory feet of the male, where they serve as receptacula seminis. In *Campodea*,

* Ann. and Mag. Nat Hist., iv. (1889) pp. 358–60.
† See this Journal, 1889. p. 633.
‡ Ann. and Mag. Nat. Hist., iv. (1889) pp. 463–73.
§ Morphol. Jahrb., xv. (1889) pp. 331–435 (2 pls.).

paired ventral saccules, very like those of *Scolopendrella*, are found at the hinder margin of the second to the seventh ventral plate of the abdomen; they are traversed by muscles and a cord of connective tissue. No distinct pores can be made out in the cuticle, and the matrix-layer is provided with a few gigantic nuclei. In *Japyx solifugus*, saccules beset with glandular hairs are to be seen on the hinder margin of the first ventral plate of the abdomen; in *J. gigas* these break up into several parts. In *Machilis* there are seven pairs of abdominal saccules with well-developed muscles and an apparently non-porous cuticle. The ventral tube of *Collembola* on the first abdominal segment has well-developed retractor muscles, a cord of connective tissue, and glandular cells with distinct pores. Living examples of *Machilis* and *Podura* show that the abdominal sacs are only protruded when the animal is completely at rest and in warm damp air. *Poduræ* creeping on a glass surface keep their ventral tube generally inactive, and the same is always the case with the abdominal saccules of *Machilis*.

The relation between the development of the tracheal system and the ventral saccules shows that the latter have a respiratory function, and are to be regarded as blood-gills; the air-tubes are absent in most of the Poduridæ, are short and open by a single pair of stigmata in *Smynthurus* and *Scolopendrella*, and by three in *Campodea;* when the common longitudinal trunks are developed the ventral saccules are reduced.

No urinary products can be detected in the abdominal saccules; the development of the saccules is affected not only by the tracheæ but also by the amount of metabolism which goes on.

It is probable that the coxal sacs found in both sexes of Diplopods have a subsidiary function as organs of attachment during copulation. The temporary vesicular appendages of *Gryllotalpa*, *Melolontha*, and others, the structure of which completely resembles that of the abdominal saccules, are to be regarded as secondary blood-gills.

The stump-like ventral appendages of *Scolopendrella* (coxal styles) are found on the second to the twelfth segments of the trunk; they are movable and are traversed by a nerve. The spinning styles of *Scolopendrella* are quite immovable, and correspond to the cerci of Insects. The pair of appendages on the first abdominal segment of *Campodea* is to be regarded as a rudimentary pair of legs; this genus has no gonapophyses in either sex. The jointed anal cerci of *Campodea* are quite like antennæ in structure, but they have no muscles. The abdominal styles of *Machilis* have flexor muscles in the anterior segments; the mid-tail of this genus corresponds to a supra-anal prolongation of the anal piece.

The abdominal styles serve especially as tactile organs and for the support of the body in locomotion or in springing, while the anal cerci have a function similar to, though less well developed than that of the antennæ.

The author concludes that the Myriopoda and Insects have a common origin; the Symphyla stand nearest to the Diplopoda, but the Pauropoda are to be regarded as degraded from the latter. The common ancestors of the Chilopoda and Insecta stand equally near to the former and to the Symphyla, but they possessed a posterior genital orifice.

The higher Insects (Pterygota) have ancestors in common with the Thysanura, with which they were closely connected. The abdominal styles are not remains of legs but secondary, paired, hairy structures which were at first purely sensory. The Collembola appear to be a direct side branch of the Thysanura. All the Pterygota had the same origin. The ventral plates of the hind-body of the Hexapoda were derived from the fusion of the abdominal legs, developed in the embryo, with the whole ventral membrane, or with a median shield, which corresponds to the sternal shield of Myriopods.

Luminous Organ of Insects.*—Dr. H. v. Wielowiejski has continued his investigations on the luminous organs of insects, and commences with a criticism of the work of other observers. In *Pyrophorus* he finds that the ventral luminous plates consist of two layers. The upper, which is generally filled with crystalline concretions, agrees exactly in structure and relations with the "urate layer" of the Lampyridæ. But the special luminous plate is of a very different form to that which is typical of the just-named family; the cells appear to be closely connected with one another; their protoplasm is close and highly refractive; on the surface there is a thickening which is not so well developed as in *Lampyris italica*. The rows of cells do not appear to be invested by a membrane of connective tissue, as Dubois supposes; the small nuclei seen by the French observer belong to the tracheal capillaries which Dubois failed to see. The author cannot accept M. Dubois's views as to the physiology of the luminous organs.

Development of Insects.†—Prof. C. Emery reviews V. Graber's researches ‡ on the development of Insects. The abdominal appendages which occur in representatives of most of the orders were studied by Graber in *Melolontha*, *Hydrophilus*, *Mantis*, &c., and are regarded as normal but rudimentary structures, the interpretation of which depends on the conclusions arrived at as to the ancestral forms. Both Graber and Emery incline to the opinion that the direct ancestors of insects were "heteropodous," and not "homopodous." Graber's observations on the origin of segments in *Stenobothrus variabilis* show that the segmenting is not superficial, but that the hypoblast divides first into four "macrosomites," and subsequently into "microsomites" or metameres, which agrees with what has been described in *Œcanthus niveus* by Ayers. Graber observes that the three thoracic segments in the hypoblast are differentiated while the three segments of the mouth-appendages are still included in an undivided macrosomite. By hypoblast, Graber means the result of the invagination of the blastoderm, to the entire exclusion of the yolk-cells or "centroblast," to which he denies all share in forming the rudiments of the embryo. In reference to the enveloping blastodermic fold (or "gastroptyche") Graber distinguishes the inner amniotic sheath as "entoptygma," the outer serous sheath as "ectoptygma." Most of the insects investigated (e. g. Hymenoptera) show the typical process of folding, the yolk lying wholly on the dorsal surface

* Zool. Anzeig., xii. (1889) pp. 594–600.

† Biol. Centralbl., ix. (1889) pp. 396–405.

‡ Morphol. Jahrb., xiii. pp. 586–615 (2 pls.); xiv. pp. 345–67 (2 pls. and 4 figs.). Denkschr. K. Akad. Wiss. Wien, liv. pp. 109–62 (8 pls. and 2 figs.).

of the embryo (*ectoblastic*), but in Rhynchota and Libellulidæ the embryonic rudiment is invaginated into the yolk, and the embryo with the ventral amnion is separated from the ectoptygma by a layer of yolk (*entoblastic*), while in Lepidoptera an intermediate mode of development occurs. Emery protests against the conclusions suggested by Graber's application of the above differences to the classification of Insects, and insists on the necessity for more extended embryological investigations.

Morphology of Lepidoptera.*—Mr. W. Hatchett Jackson, in his paper under this title, deals with two points in the anatomy of the Macrolepidoptera—the external anatomical indications of sex in the chrysalis, and the mode in which the azygous portion of the oviduct with its accessory organ developes in the female. It seems to have escaped the notice of all observers that it is perfectly easy to determine the sex of a given chrysalis; the distinctive characters are to be found in the sternal region of the ninth abdominal segment in the male, and in the corresponding region of both the eighth and ninth abdominal somites in the females. The male has a fine short line corresponding to the aperture of the ductus ejaculatorius, and this line has two small oval lips. The female has typically two fine linear depressions which correspond to the paired vesicles invaginated from the larval hypodermis, and to the apertures of the bursa copulatrix and oviduct in the adult.

One of the greatest peculiarities of the Lepidoptera is the existence, in connection with the female reproductive organs, of two separate external apertures, that of the bursa copulatrix, and that of the oviduct. Mr. Jackson has made an investigation of the development of these parts in *Vanessa Io*, and comes to the conclusion that the aperture of the bursa copulatrix belongs to the eighth somite, and is, strictly speaking, the homologue of the single genital aperture of other Insecta; the Lepidoptera have really two post-genital somites intervening between the genital aperture and the anus, and the oviducal aperture is an acquired peculiarity. While these statements are true of most Lepidoptera, it is recognized that variations may occur, as in *Nematois metallicus*, described by Cholodkowsky.

Three distinct stages appear to be indicated in the phylogenetic history of the female reproductive organs. In the first stage paired larval oviducts opened at the posterior border of the seventh abdominal somite, as in existing Ephemeridæ. If accessory organs were present they opened independently on the two succeeding somites. In the second stage a short vagina or azygous oviduct, derived from the hypodermis of the eighth somite, made its appearance. The bursa copulatrix and receptaculum seminis opened close behind its aperture or into it on its dorsal aspect, while the sebaceous glands retained a separate aperture. Very similar arrangements obtain in many living Orthoptera. Finally, in the third stage, the sebaceous glands open into a continuation of the vagina which possesses a second terminal aperture—a disposition of the parts which is specialized in the Lepidoptera.

* Zool. Anzeig., xii. (1889) pp. 622-6.

Alimentary Canal of Lamellicorn Larvæ.*—Dr. P. Mingazzini describes the alimentary tract in the larvæ of *Oryctes*, *Phyllognathus*, *Cetonia*, *Tropinota* and *Anomala*—phytophagous Lamellicorns. The histology and physiology of each of the three regions of the gut are discussed at great length; among the many special points worked out we may notice the dimorphism of the epithelial cells in the posterior part of the œsophagus, the disposition of the muscular fibres on the mesenteron, the nuclear crystalloids of the midgut-epithelium, the chitinous structures of the proctodæum, and the nuclear degeneration in the epithelium of the hindgut-sac.

The alimentary canal of Insects exhibits two extreme types:—one in which the stomodæum is very slightly developed (as in the above larvæ), while the proctodæum is long and complicated; another is seen in Orthoptera where the stomodæum is greatly developed, but the proctodæum relatively reduced. In the primitive Thysanura both types occur, the gut of *Machilis* resembling that of Lamellicorns, while in *Nicoletia* or *Lepisma* the other type is approached. The author associates the extreme types of alimentary apparatus with the different habits of the members of the two orders referred to above, and finds another factor of variability in the degree of digestive power possessed by the mesenteron in different insects. He also emphasizes the differentiation consequent on the proctodæum acquiring a distinct absorbent function as in Lamellicorn larvæ.

The chitinous structures in the stomodæum and proctodæum are physiologically of three kinds:—those which serve for trituration, e. g. teeth and spines; those which retain the food, such as the tree-like structures in the hindgut of Lamellicorn larvæ; and those which are directive. Foremost among the peculiarities of the two regions derived from the ectoderm, Mingazzini notices the chitinous cuticle, which must be chemically as well as microscopically determined. Another character, which in the higher insects is only seen in the proctodæum, is the folding, best seen in the rectum. The author notes the possibly primitive hexamerous symmetry of the intestine: thus, the mesenteron of Lamellicorns exhibits double dorsal and double ventral muscular bundles, which with the two laterals make six divisions. He derives some support for this theory from the researches of Miall and Denny on the cockroach. He discusses Eisig's comparison of the chitin in Capitellidæ with that of insects, but sought for the fibrillar structure which Eisig described without finding any trace of it. The chitin is regarded simply as a cuticle with peculiar chemical properties. The cæca of the mesenteron are portions specialized for regular secretion, in virtue of being out of contact with the food. The presence of unstriped muscular fibres in the tunic of the mesenteron leads the author to discuss the distribution of these elements, to protest against certain generalizations on this subject, and to note the intermediate forms between the striped and unstriped types. It is interesting to find that in no region of the gut did Mingazzini discover karyokinetic division of the nucleus. The unique crystalloids in the degenerating nuclei of midgut cells are probably waste products.

* MT. Zool. Stat. Neapel, ix (1889) pp. 1–112 (4 pls.).

Parasitic Bees.*—Prof. E. Hoffer gives an account of the genus *Psithyrus*, the members of which are parasitic in the nests of humble-bees, which they very closely resemble. The female may be distinguished from a humble-bee by the less curved tip of the abdomen, by the raised ventral ridges which converge from the sides to the tip, by the absence of collecting apparatus, by the somewhat naked and shining back, and by certain differences in labrum and mandibles. The males, which are much smaller than the females, may be distinguished from species of *Bombus* by the relatively short head, by the externally convex and uniformly hairy tibia of the posterior legs, by the almost membranous and light-coloured genital appendages, and by several other characteristics. There are only male and female forms of *Psithyrus*,—the latter appearing in spring, the former decidedly later. After describing the structure of the body, the author gives a very interesting account of the mode of life of both sexes. He describes the slow flight of the females in early spring, their sluggishness except in bright sunshine, their deliberate and thorough robbery of a few flowers, and their determined search for *Bombus* nests. An entrance is effected by force, but apparently only into those nests which contain either a solitary queen *Bombus*, or only a few workers. The egg-laying of the *Psithyrus* was not observed. Only the stored pollen and honey of the hosts are devoured by the adult parasites at least, but the consequence is always that the humble-bee colony ceases to flourish. It is possible, or even probable, that the larvæ of the *Psithyrus* devour those of their hosts, but the mother probably superintends the nutrition of her larvæ, and also forbids the entrance of other claimants. The lives of the males in the two genera are as similar as those of the females are different; and, as in the case of *Bombus*, the males of *Psithyrus* all die in the cold and scarcity of food associated with the advent of autumn. Professor Hoffer describes six species of *Psithyrus* from the Steiermark district.

Parasitic Castration of Typhlocybæ.†—M. A. Giard gives an account of his observations on the parasitic castration of *Typhlocyba* by the hymenopterous larva *Aphelopus melaleucus* and the dipterous larva *Atelenevra spuria*. Like their hosts, these insects have two generations in the year. The researches of Mr. James Edwards show that what, in a previous note, M. Giard called *T. rosæ* L. should be distinguished into *T. hippocastani* J. Edw. and *T. Douglasi* J. Edw. *Aphelopus* usually attacks the former and *Atelenevra* the latter. Parasitism by *Aphelopus* generally causes the ovipositor to be much reduced and incapable of penetration, but *Atelenevra* seems to have much less influence. The penis, on parasitic castration, undergoes considerable reductions, and the specific character is greatly modified.

Certain singular organs, hitherto overlooked in the males of *Typhlocyba*, have the form of two invaginations of the ectoderm, which start from the ventral surface of the first abdominal segment, and extend, like the fingers of a glove, to the extremity of the fourth segment; these the author regards as homologous with the stridulating organs of the male Cicadas. When the males are parasitically infested the ventral invagi-

* MT. Nat. Verein Steiermark, xxv. (1889) pp. 82–158 (1 pl.).
† Comptes Rendus, cix. (1889) pp. 708–10.

nations are much reduced, and may form only two little pockets on the first segment.

Aphelopus melaleucus appears to be pretty common; in Wimereux and at Meudon the sac which contains the larva is of a blackish colour, and not yellow, as in the Luxembourg Garden. This colour is evidently protective of the more numerous individuals living on *T. ulmi*, the abdomen of which is black, and is probably due to heredity in the others. It is possible that *Aphelopus* presents varieties in the different species of *Typhlocyba* which it infests.

Phytophagous Habits of the Larva of Friganea.*—Dr. D. Levi-Morenos finds that the larvæ of different species of *Friganea* (Neuroptera), usually stated to live on aquatic flowering plants, comparatively seldom feed on the green parts of the plant, though occasionally on the root and epiderm. He finds, on the other hand, the alimentary canal loaded with diatoms of many different species. From some of these the endochrome is entirely removed in the process of digestion, while others remain comparatively intact.

Embryology of Blatta Germanica and Doryphora decemlineata.†—Mr. W. M. Wheeler gives a detailed account of his observations on the development of the cockroach and the potato-beetle. In all the details of their history the two forms differ strikingly, but their main ontogenetic features are as strikingly similar.

After an account of the ovaries and modes of oviposition the development of the egg is described as far as the formation of the blastoderm; though the author adds something more to our knowledge of the copulation of the pronuclei than Blochmann, he considers that the process must be studied in Arthropod eggs with more evenly compact yolk than those of the Orthoptera, the numerous cracks and fissures in which render the observation of delicate internal processes exceedingly difficult, if not impossible. The nuclei, at one time in the yolk, all appear to rise to the surface to form the blastema and reinforce it in its formation of the blastoderm.

The author maintains that a portion of the chromatin of the insect-egg visibly survives in the decomposition of the germinal vesicle, and can be traced through the divisions resulting in the formation of the two polar globules into the cleavage-nucleus and its descendants. In other words, there is no moment when the nucleus ceases to exist as nucleus. Particular attention was paid to the determination of the paths of the pronuclei and cleavage-nucleus in *Blatta*, and experiments were made on the possible effects of gravitation. The conclusion arrived at is that the force of gravitation has no perceptible effect on the development of the eggs of *Blatta*; their highly differentiated eggs, utterly unable to revolve in their envelopes like the eggs of birds and frogs, have their constituents prearranged, and the paths of their nuclei predetermined with reference to the parts of the embryo. The spherical form of the crustacean egg, as opposed to the oval shape of the great majority of insect-eggs, will be a great obstacle in the way of extending this generalization to the lower group.

* Notarisia, iv. (1889) pp. 775–80.
† Journ. of Morphology, iii (1889) pp. 291–372 (7 pls.).

The formation of the germ-layer, and embryonic envelopes is next discussed. The method of germ-layer-formation in *Blatta* is, at first sight, very different from that observed in *Doryphora;* but a study of the latter helps to explain the conditions which obtain in the former, and makes it probable that the endoderm of *Blatta* originates in the mass of cells found under the area of proliferation, the more superficial cells of which form the mesoderm.

The embryonic envelopes and the dorsal organ which are formed soon after their rupture, offer a good deal of difficulty. In considering the meaning of the amnion and serosa of Hexapoda, we must postulate that (1) there are no sufficient reasons for homologizing the embryonic envelopes of insects with the homonymous but dissimilar structures in Myriopods, Scorpions, and *Peripatus;* (2) there is no more than a superficial resemblance to speak for a homology between the dorsal organs of the Crustacea and the embryonic envelopes of Insects, and between the dorsal organs of the former and the homonymous structures in the latter; (3) the dorsal organ of insects may be regarded as the necessary result of the rupture and absorption of the embryonic envelopes, and, consequently, as in no way related to such structures as the dorsal organs of *Cymothoa*, *Limulus*, and others. There is a complete series of finely graduated forms of envelope-formation from that seen in *Calopteryx* to that which obtains in *Blatta*, *Aphis* representing the first step in the transition of an entoblastic into an ectoblastic embryo. The author concludes that the typical ectoblastic originated from the typical entoblastic embryo, not by an extrusion of the yolk from between the amnion and serosa, but by a gradual weakening of the invaginative process. This weakening results in more and more of the anterior portion of the ventral plate remaining inert, though the growth of the membranes to shut off the amniotic cavity continues.

The term "dorsal organ" is applied to the peculiar thick lump of cells which results from the concentration on the dorsal yolk of the remains of either the amnion or serosa or of both, preparatory to their absorption in the yolk. Its presence in Insects is probably due to the fact that the embryonic envelopes are to be absorbed. These membranes might either undergo dissolution *in situ*, or they might be brought together in a mass, and swallowed up by the yolk somewhere in the median dorsal line. The latter method is obviously the more advantageous as the body-walls, which are continually growing towards this dorsal line, might be impeded in their advance, if the membranes were absorbed at all points on the surface of the yolk.

In conclusion, Mr. Wheeler gives an account of the fate of the different germ-layers. We have only space to note that the frontal ganglion is formed as an unpaired thickening of the dorsal wall of the œsophageal ectoderm near the base of the labrum; the outer neurilemma is of ectodermal and not of mesodermal origin, for shortly after the separation of the nerve-cord from the integumentary ectoderm, it sheds from its surface a delicate chitinous cuticle, simultaneously with the shedding of the first integumentary cuticle.

β. Myriopoda.

Anatomy of Chilopoda.*—Herr B. Schaufler gives an account of the generative organs of *Lithobius*, *Cryptops*, and *Geophilus;* the author differs in a number of important points from Fabre. Glands which have a certain relation to the receptacula seminis are always well developed; they are inferior to another pair of glands which vary in the extent to which they are developed, and which may have the function of providing protective envelopes for the ova against external influences. The feeble development of the glands in *Cryptops* and *Geophilus* may perhaps be made up for by the care of the young which the members of these genera exhibit. It is difficult to speak with any certainty as to the habits of these shy and nocturnal animals, but it is very probable that copulation does obtain among the Chilopoda.

Structure of Gizzard in Scolopendridæ.†—Dr. V. Willem finds that in *Scolopendra*, *Scolopocryptops*, *Cryptops*, and, probably, in other genera of the Scolopendridæ there is a gizzard which has the same fundamental constitution as that of Insects. In *Scolopendra* it has a thick muscular wall, the interior of which is grooved by projecting longitudinal folds ; on these there is a crown of protuberances directed forward, and formed by the chitinogenous layer and the cuticle of the anterior intestine. The form of the protuberances varies in different species. In *Scolopocryptops* and *Cryptops* the gizzard is an ovoid swelling of the buccal intestine, provided internally with chitinous processes which are directed towards the œsophagus. The armature of the organ is most complicated in *Cryptops*, with which nothing among Insects but that of *Corethra plumicornis* can be compared.

δ. Arachnida.

Parasite of the Slug.‡—M. P. Mégnin describes an Acarid which appears to have been known for a long time as parasitic on the grey slug (*Limax*). It is identified as *Ereynetes limacium*, is included in the family Trombidiidæ beside the genus *Tydeus*, and has a near relative in the orange-coloured *Ereynetes velox* which infests dung-eating insects. The parasite of the slug is blind, of a white colour, and moves with rapidity on its host. The females, males, nymphs, and hexapod larvæ are described. They seem to live on the mucus of the slug, and ought, perhaps, to be called commensals.

Anatomy of Pentastomida.§—Herr E. Lohrmann gives an account of the anatomy of the Pentastomida. Contrary to Leuckart, he finds that the outer soft chitinous investment is distinctly striated, for sections show an alternation of lighter and darker bands, of which, in some parts there may (in *P. tænioides*) be as many as twenty. In the harder parts of the cuticle, such as the hooks and their supporting plates, there is no striation, but there are a number of small irregular spaces which are sometimes arranged in rows or layers. The author does not alto-

* Abh. Zool.-Bot. Gesell. Wien, xxxix. (1889) pp. 465–77.
† Bull. Soc. Acad. Roy. de Belgique, lix. (1889) pp. 532–46 (1 pl.).
‡ Journ. Anat. et Physiol. (Robin), xxv. (1889) pp. 570–2 (1 fig.).
§ Arch. f. Naturgesch., lv. (1889) pp. 303–37 (1 pl.).

gether agree with Leuckart as to the disposition of the musculature, and he points out that, to completely understand that of *P. tænioides*, it is well to examine young forms; these have not the flattened form of older examples, but are rounded, and the oblique system of muscles is limited to the sides. The species exhibit some differences among themselves as to the arrangement of the muscles.

Sensation does not appear to be confined to the two so-called tactile papillæ at the anterior end of the body. There are a number of small warty-like bodies, which are generally paired, in the anterior region; their cuticle is broken through at one point and the cleft is filled by a closely packed tissue, the elements of which are arranged in parallel rows and are directed outwards. At their inner ends they are connected with undoubted nerve-fibres. The functions of these organs would appear to be to give information to the larva when it has acquired a suitable resting-place and perhaps also to allow the male to discover the female. Herr Lohrmann is not inclined to agree with Leuckart in regarding the so-called tactile papillæ as rudimentary antennæ. The differences exhibited by different species are pointed out.

It seems to be impossible to understand clearly the relations of the mouth without the aid of sections; this method was first used by Hoyle, and to his account the author makes some corrections and additions; to Leuckart's description of the œsophagus the author has only to add that there are longitudinal as well as circular muscles; the cells of the mid-gut have not the special fringe noticed by Frenzel and others in many other Arthropods.

The author enters at some length into an account of the secretory organs, and gives reasons for regarding them as belonging to two, and not as did Hoyle to three distinct groups. In his account of the male generative organs his most important points are some remarks on their more minute structure; on the whole, they have already been fully described by Leuckart. And, similarly, he has but little to add to what is generally known as to the characters of the female organs.

Dr. Lohrmann cannot agree with Hoyle in regarding Leuckart's subgenera *Linguatula* and *Pentastomum* as having generic value. The only sharp distinction is the double testis of *P. tænioides* and the form of the body; but the latter is clearly due to the characters of the region inhabited. Adults with rounded bodies are found in the round spaces in the meshwork of the lungs, while the flat forms live in the flat spaces of the nasal cavities. Some of the described species are apparently only stages of growth, and *P. polyzonum* would appear to have had six names. Finally, there are descriptions of two new species—*P. platycephalum*, the host of which is unknown, but is probably an Alligator, and *P. clavatum* from the lungs of *Monitor niloticus*.

ε. Crustacea.

Crustacea of Canary Islands.*—Prof. C. Chun confines himself to an account of the Amphipoda, Schizopoda, and Decapoda collected by him on his visit to the Canaries. Although he allows that all the names as yet given to forms of *Phronima* are synonyms of *P. sedentaria*, he finds

* SB. K. Preuss. Akad. Wiss. Berlin, 1889, pp. 527–39 (10 figs.).

himself justified in naming a new species which he calls *P. Diogenes*; it lives in depths of from 350 to 1500 metres; the characters by which it differs from the well-known species are carefully pointed out in detail. Three specimens were found of the rare *Rhabdosoma armatum*. *Oxycephalus piscator* and *O. typhoides* were found to be commensals of *Eucharis multicornis*.

A description is given of a remarkable new Amphipod, called *Fortunata lepisma*, which it is somewhat difficult to associate with any of the known families. It agrees with the Gammaridæ in the small size of the eye and of the cephalic segment, while the want of a lateral compression of the body and the form of the segmental appendages calls to mind some of the Hyperina. Milne-Edwards rightly insisted on the value of the form of the antenna as a characteristic of the latter group; of these, the Phronimida, like *Fortunata*, have the anterior antennæ two-jointed, while the hinder antennæ are absent in the female. On the whole, however, the characters of this new form are sufficiently peculiar to justify the formation of a new family—that of the Fortunatæ—for its reception. The author adds a diagnosis of the family.

In the Atlantic, as in the Mediterranean, the Schizopoda form a very characteristic part of the pelagic fauna. The remarkable *Euchætomera typica*, described by G. O. Sars in the 'Challenger' Report, is now for the first time definitely stated to inhabit the Atlantic. By the astounding length of its upper antennæ, which were broken off in the Pacific Ocean specimens obtained by the 'Challenger,' by the size of its endopodites, the remarkable shortening of the carapace and telson, this form is characteristically intermediate between *Mysis* and the *Arachnomysis Leuckartii* which the author has described from the depths of the Mediterranean. *Stylocheiron mastigophorum*, first found in the Mediterranean, was found at all depths. *S chelifer* sp. n. is so called on account of the size of its chelæ; its antennæ are as long as its body.

Sergestes sanguineus sp. n. is so called on account of the blood-red coloration of its astonishingly long lower antennæ, which are more than four times as long as the body; it is distinguished from all the Sergestidæ yet described by the extraordinary development of its penultimate thoracic legs.

Differences in Developmental History of Marine and Freshwater Forms of Palæmonetes varians.*—Dr. J. E. V. Boas points out that the species hitherto known as *Palæmonetes varians* contains two forms; one, northern and marine or brackish in habitat, the other more southerly in distribution and a dweller in fresh water. The adults are so like one another that there could be no reason for separating them specifically, but their developmental history is very different. The egg of the freshwater form has eight times the volume of the marine; the latter leaves the egg as a gill-less zoea, passes through a normal Mysis-stage, and takes food from its birth. The freshwater form appears as a much better developed zoea, and has gills; the exopodites of the thoracic feet are only slightly developed, so that there is only an indication of the Mysis-stage—i. e. there is an abbreviation of the metamorphosis; and in consequence of the large quantity of the nutrient

* Zool. Jahrb., iv. (1889) pp. 793-805 (1 pl.).

yolk with which it leaves the egg, and which is only gradually absorbed, the young animal does not take food from outside till very late, and the maxillary palps are, consequently, for a long time without setæ. The freshwater form is to be regarded as having been derived from the marine; and its peculiarities are analogous to those which we often find in other freshwater animals which have allies in the sea. The peculiarity of the case lies in the fact that the adults of the two forms have remained almost exactly alike, while the development has become so very different.

Vermes.

α. Annelida.

Development of Annelids.*—M. L. Roule has a lengthy memoir on the development of Annelida, based chiefly on a study of *Enchytræoides marioni.* The embryos pass through the early stages of their development in cocoons, and escape when they have from fourteen to fifteen rings. Segmentation is complete and somewhat unequal; as a rule there is no cavity comparable to a blastocœl; a planula is formed by tangential division of the cells, and the interior is at first a mesoendoblast, and is extensive. As an archenteron appears the endoblast becomes distinct as a single layer of cells from the five or six rows that form the mesoblast. We have already noted † the author's description of the formation of the cœlom. As the embryo elongates and becomes cylindrical the archenteron and cœlom increase in size; the ectoblast of the anterior end of the body thickens to form the cephalic plate, and a similar medullary plate appears on the ventral surface. As the embryo elongates it becomes narrower, and four or five rings appear in the anterior region of the body; septa begin to extend from the somatopleure to the splanchnopleure, and the cephalic lobe becomes marked off as the most anterior segment of the body. The ectoblast becomes depressed in relation to the septa, so that an external annulation corresponds to the internal segmentation of the mesoblast and cœlom. The dorsal and ventral portion of the central nervous system next become united. Behind the last ring there is a large mass of mesoblast in which closed cavities are hollowed out by pairs, on either side of the digestive tract. The setæ are formed at the expense of the ectoblast, and the muscles which move them from the somatopleure. The external and sub-ectoblastic cells of the somatopleure begin to be differentiated into smooth muscular fibres by the formation of contractile substance at their periphery; they thus become fibre-cells, comparable to those of Molluscs.

The nephridia appear in the form of a continuous cord, which becomes differentiated in the deep region of the somatopleure; this cord divides into groups of four or five cells, which become connected with the septa. The cells of the group fuse, and vibratile canals become hollowed out in the mass. After expulsion from the cocoon the body of the embryos continues to elongate, and two blood-vessels begin to appear; these trunks join and fuse; at first each trunk is represented

* Ann. Sci. Nat., vii. (1889) pp. 107–442 (15 pls.).
† See this Journal, 1889, p. 387.

by an empty space without proper walls, placed between the splanchnopleure and the endoblast; this may be considered as a blastocœl-space, which does not and never will communicate with the cœlom. Later on, the splanchnopleure furnishes the vessel with a complete wall. When the two vessels are continuous along the whole of their course they give rise to anastomosing loops which unite the two.

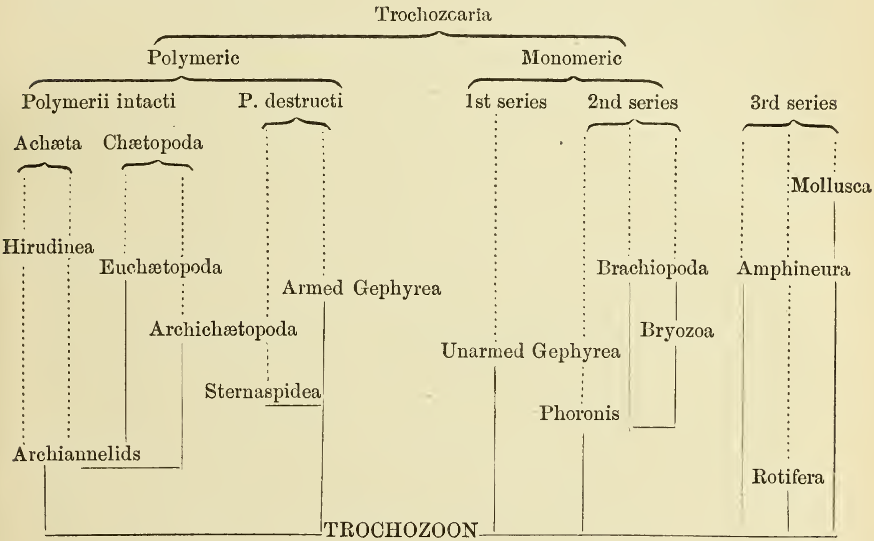
The seventh stage, in which the worm has thirty rings, is characterized by the appearance of the gonads and sperm-ducts. To begin with, the pair of nephridia in the eleventh ring is absorbed and disappears; the rudiments of the testicle and ovary then appear in the eleventh and twelfth rings respectively; they are altogether derived from the peritoneal endothelium of the septum, which forms the anterior boundary to the ring in which they appear. The rudiments of the testicle grow rapidly, and divide into lobes, while the cells which form them become fused into a symplasm, in which a number of small nuclei are scattered. The rudiments of the ovaries remain undivided, and their cells, though closely packed, do not fuse. The two sperm-ducts appear in the twelfth ring in the place of the segmental organs, which are not there developed; their origin and mode of development resemble in all points those of true nephridia; so that the homology of the two sets of organs cannot be doubted. They are put into relation with the ectoblast of the wall of the twelfth ring to form the penis. In the adult stage the body of the worm measures 12 to 15 mm. in length, and has about fifty rings; the clitellar region is a little wider than the rest of the body, owing to the thickening of the ectoderm, in which there are numerous mucous cells, and to the distension of the walls by the contained gonads. The author describes the phenomena of spermatogenesis and oogenesis. When the adult has discharged its gonads the tissues of the organs undergo degeneration, and the individual dies. The act of reproduction appears, therefore, to be the term of life in this species.

The absence of initial mesoblasts does not appear to be peculiar to the embryos of *Enchytræoides;* it seems, on the contrary, to be the rule in all condensed developmental histories of Annelids. Similar facts have been noted in other groups of animals, for, e. g. the enterocœle of *Amphioxus* appears to be wanting in most other Vertebrates, where the mesoblast is separated by a simple cleavage of a primordial layer, which corresponds to the meso-endoblast of Annelids. When a mesoblast is formed in *Enchytræoides* it is homologous with the mesoblastic bands of the larval trochosphere. The differences between the embryo now described and the trochosphere are due to the condensation of development in the former. The difference between the descriptions now given and those of the development of other Oligochæta are considerable, but are probably largely due to the want of technical appliances which obtained when these latter were drawn up.

With regard to the systematic position of Annelids, M. Roule agrees with Hatschek in allying them to the Mollusca; it is very probable that both Annelids and Platyhelminths were derived from a group of Cœlomata which had a very simple structure, similar to that of the trochosphere-larva. The whole group may be called the Trochozoaria, and divided into those that are polymeric or segmented and those that

are monomeric or not metamerically segmented. Of the former there are two series; in some the segmental cavities of the larva persist in the adult, while in others the septa are destroyed in such a way that the definite cœlom resembles that of the monomeric Trochozoaria. The former may be said to have persistent segments, the latter to have the segments destroyed; to the former belong the Archiannelids, Hirudinea, Archichætopoda, and Euchætopoda, and to the latter *Sternaspis* and the armed Gephyrea.

The monomeric Trochozoaria contain a certain number of classes, of which it is difficult to estimate the relations; three series are, however, well marked. In the first are the unarmed Gephyrea, in the second the Bryozoa, Brachiopoda, and *Phoronis*, and in the third the Rotifers, Amphineura, and Mollusca. The relations of these are shown in the table.



Earthworms from Western Himalayas and Dehra Dun.*—Prof. A. G. Bourne records the presence of *Perichæta houlleti*, immature examples of what is perhaps a new species of *Perionyx*, and *Typhæus Masoni* sp. n. from Dehra Dun, which lies at the foot of the Western Himalayas. From Masouri, which is at an elevation of between 5000 and 6000 feet, he has received three species of *Lumbricus* or of some allied genus or genera, and two species of *Perionyx;* the latter were immature, and the author refrains from naming the former as he could only give an incomplete description, and the literature with regard to the genera and species of Lumbricidæ is already in great confusion. Fletcher has recorded the presence of the same species of Australian earthworm at very various altitudes, but in India all the species from hill stations seem to differ from those of the plains. Among other

* Journ. Anat. Soc. Bengal, lviii. (1889) pp. 110–17 (1 pl.).

points, *T. Masoni* is remarkable for the mode of arrangement of the setæ in the posterior third of the body; they are not arranged in couples as in the anterior two-thirds, but are equidistant from one another; and this disposition gives the worm a striking appearance.

β. Nemathelminthes.

Development and Anatomy of Gordius tolosanus.*—Dr. O. v. Linstow gives an account of the anatomy and development of *Gordius tolosanus* Duj. It is probable that the small embryonic larvæ are encapsuled in the aquatic larvæ of *Ephemera*, *Corethra*, *Chironomus*, and *Tanypus*, and that the large forms live freely in the body-cavity of terrestrial beetles, which fall into the water in spring, whence the Gordii again reach their proper element. The passage from one host to the other can only be effected in late summer when pools and ponds begin to dry up, and the beetles are able to get at and eat the dipterous aquatic larvæ. The larvæ return to the water in April, and at the end of June sexually mature examples are found in the water.

In the cutis of the larva Dr. v. Linstow was unable to find the four layers described by Camerano, the external cuticular and the fibrillar layers being alone present. The muscles are all longitudinal and the long muscle-cells have an elongated, rod-like nucleus; the differences in the arrangement of the muscles at the hinder end of the body in the larval males and females are pointed out. The cell-body serves partly as a support for the internal organs, partly as packing, and partly as a formative body for the testes and ovaries which are as yet undeveloped; the segmented arrangement of the cells is remarkable. Both male and female larvæ present, in transverse sections, two lateral, symmetrical, and one asymmetrical cavity; in the latter lies the enteron and at its ventral surface the nerve-cord, and the author regards it as the cœlom. It differs in form in the two sexes. The anterior part of the digestive tract becomes closed in the larger larvæ; the thick commencement of the œsophagus is made up of two lateral and symmetrical halves. The intestine has a distinct lumen; in the male the efferent ducts of the genital tubes open into the terminal part of the intestine, and in both sexes the end of the gut has a very wide lumen and very thick walls. The central nervous system commences just behind the mouth with two partly-developed swellings which are connected with a large nervous mass which entirely surrounds the œsophagus; a little further back the organ consists of three distinctly differentiated cords which lie close to one another, and are supported at their base by a nucleated mass. The author's account of this part of the nervous system differs altogether from that of M. Villot. With Camerano, the author denies the existence of an intermuscular or interparenchymatous water-vascular system, which has been described by Villot.

In sexually mature forms, ocelli, which have been hitherto overlooked, were observed; they are two small lenses surrounded by black pigment spheres and separated from one another by 0·082 mm. The walls of the two spaces which lie symmetrically on the dorsal side of the cœlom and extend through the whole length of the male, are converted into the

* Arch. f. Mikr. Anat., xxxiv. (1889) pp. 248-68 (3 pls.).

testes; the spermatozoa are short thick rods, one-half of which is thinner than the other. The ovaries of young females are organs filled with cells, which begin just behind the head, and soon become so large that they nearly fill up the space in the body. The structure of the gonads of both sexes is described in some detail. The external copulatory organs described by Vejdovsky do not seem to exist in *G. tolosanus*; the "bursa" would appear to be a hardened mass of sperm, and the cirrus an artifact.

Dr. Linstow thinks that the *Gordii* are allied to the Annulata by the segmentation of the cell-body and of the ovaries, by the double nature of the male organs, and the ventral position of the nerve-cord; while, on the other hand, their developmental history, as lately described by Camerano, allies them to the Nematodes.

Notes on Mermis.*—As a continuation to the above, Dr. v. Linstow offers some notes on *Mermis*. He gives descriptions of the new aquatic forms which he calls *M. contorta* and *M. crassa*. The former is very elongated and thin, the male being 14·8 mm. long, and 0·17 broad, while females were found which measured 24·1, 42, 44·8, and 49 mm. with the respective breadths of 0·23, 0·28, 0·26, and 0·28 mm. In the median axis of the œsophagus there is a strong chitinous tube. *M. crassa* is much more robust then *M. contorta*, and offers some important anatomical differences from *M. albicans* and *M. nigrescens*. The cuticular stratum consists of four layers—a fine, homogeneous epidermis, a superficial corium in which two systems of fibres cross one another, a somewhat thicker corium-layer which consists of circular fibres, and a fine hypodermis. Six very well-developed longitudinal ridges extend through the whole length of the body; they are due to thickenings of the hypodermis, and are best developed in the region of the head. The musculature breaks up into six nearly equal longitudinal areas; in the anterior part of the body the muscles are very powerful, but posteriorly they become much thinner. The nervous system consists of a large brain, and a ventral nerve-cord which, alternately to right and left, gives off at right angles to the cord nerve-trunks which inclose ganglionic cells; these nerves are inserted into the muscles, and extend over the lateral areas. Between the musculature and the internal organs there is a finely granulated layer, which is well developed at either end of the body, where the cell-body is wanting. This body has an investing membrane within which are hyaline spheres; these are feebly stained by borax-carmine, and are dissolved by xylol; it must not, therefore, be called a fat-body.

Mermis appears to form a link between *Gordius* and the Nematodes; with the former it has in common the mode of life, the annellation of the body in quite young larvæ, the presence of a cell-body, and a ventral nerve-trunk. The generative organs of *Mermis*, which have the form of a flat, broad band very rich in nuclei and placed asymmetrically on one side of the body, are quite similar to those of Nematodes.

Sexual Elements of Ascaris of Dog.†—Herr S. M. Lukjanow has made a series of sections of the sexual tubes of the *Ascaris* of the Dog.

* Arch. f. Mikr. Anat., xxxiv. (1889) pp. 390–6 (1 pl.).
† T. c., pp. 398–408 (2 pls.).

In the deepest portions of the ovary the spherical nuclei of the egg-cells are regularly provided with a centrally-placed nucleolus, which possesses the characters of a plasmosoma. Karyokinetic figures appear in some numbers notwithstanding the small size of the cell. Within the ovaries the egg-cells have a delicate plexiform structure, which is barely noticeable, and paraplasmatic contents are not to be seen. As they pass to the oviducts the spherical form is more and more replaced by the pyramidal, and the dimensions of all the parts increase, though not regularly. As maturation proceeds, yolk-spherules appear in the body of the egg-cell and lie in the rounded meshes of the protoplasmic network; the nuclei of these cells become stellate, and no distinct membrane can be demonstrated; the nuclear substance appears to be almost homogeneous, and karyokinetic figures are only rarely seen.

The structure of the nuclei of the egg-cells does not long remain simple; very many of the stellate nuclei give off new elements, which are of great importance in the formation of the chromatin elements which pass into the polar corpuscles.

In the parts of the oviduct which lie nearer the uterus the egg-cells take on a more or less spherical form, and further changes go on in their nuclei. The formation of polar bodies is cotemporaneous with the entry of the spermatozoa into the egg-cell; ordinarily only one sperm-cell enters the egg-cell; it then soon undergoes a peculiar disintegration; the head becomes rounded, and instead of having the form of a horn, is more or less spherical; it separates from the other parts of the spermatozoon. It now either lies freely in the body of the egg-cell, or is surrounded by a small quantity of a peculiar substance which appears to have the characters of protoplasm.

The male and female pronuclei appear to be exactly similar, save that one is ordinarily larger than the other; their karyokinetic metamorphoses exhibit some remarkable peculiarities, the loops becoming well stained with safranin, which is not the case when the polar bodies are being formed, and each loop is made up of granules arranged in the fashion of a rosary. The blastomeres have nuclei which are similar to the pronuclei.

The author concludes by pointing out the great value of the method of combined staining in distinguishing the various processes which go on in developing and fertilized ova.

γ. Platyhelminthes.

Development of Distomum macrostomum.*—Dr. G. A. Heckert gives a monographic account of *Leucochloridium paradoxum* and its adult form *Distomum macrostomum*. The larvæ have long been known as brightly coloured vesicles in the horns of the snail *Succinea amphibia*, but Zeller was the first to demonstrate (in 1874) the connection between these and the adult *Distomum* parasitic in singing birds. What Zeller did in outline, Heckert has completed in detail. He starts from the sporocyst threads which penetrate the liver of the snail in all directions, and describes how parts of this meshwork acquire with the growth of the germs a very different structure, becoming brightly coloured pulsating

* Bibliotheca Zoologica (Leuckart and Chun), Heft iv. (1889) pp. 66 (4 pls.).

vesicles superficially like the segmented larvæ of Diptera. After describing the histology of *Leucochloridium*, Heckert gives an account of his experiments in infecting songsters with this parasite. The results enabled him to trace the transition from larva to adult. In four days after infection the change is complete, and in fourteen days the eggs are liberated. The *Distomum* inhabits the cloaca of the bird, and the eggs were frequently observed in the fæces and urinary products. The most characteristic peculiarities of the adult are the nature of the head end and the position of the genital aperture. The dorsal wall of the mouth-sucker is much longer than the ventral, and the aperture is sharply inclined to the ventral surface; both suckers can thus be used at once for attachment, which is probably important in such a situation as the cloaca. The genital aperture is not ventral, as is usually the case, but terminal, or even turned towards the dorsal surface.

So far as Heckert was able to follow the first stages in the development of the egg, Schauinsland's account of the embryology of Trematodes holds true. After describing various steps in the development, the author passes to the ciliated free-swimming embryo. He was able to demonstrate that the chemical stimulus of the snail's digestive secretion was of itself sufficient to bring the embryo out of the egg-shell. By sections he detected the embryos in process of boring through the wall of the gut, and believes that the cilia are lost at this stage. The sporocysts found in the adjacent organs of the snail begin as small, almost spherical bodies, within which a rapid multiplication of cells takes place with direct nuclear divisions. The appearance of an internal cavity and a distinct germinal epithelium, the liberation of egg-like cells into the cavity of the sporocyst, and the curious root-like ramifications noticed at the outset are described in detail. It is important to note that it is always a single cell in the germinal epithelium of the sporocyst-wall which starts a "germ-ball" or a fresh individual, so that Leuckart's comparison of "germ-cell" and ovum is corroborated. The development of the "germ-balls" into larvæ, and the histological differentiation exhibited in the process are, finally, described.

Position of Excretory Pores in Ectoparasitic Trematoda.*—Dr. M. Braun who has been surprised at the variations in the statements affecting the position of the excretory pore in ectoparasitic Trematodes, some authors saying it is ventral and others dorsal, has made an investigation by the method of sections—the only safe one—and found in all forms examined that the pores were dorsal in position.

Larva of Tænia Grimaldii.†—M. R. Moniez gives a description of cysts collected from various dolphins in the Atlantic during the voyage of the 'Hirondelle.' The other host, or that which contains the adult, will probably prove to be *Orca* or a Dolphin, as these animals are cannibal in their habits. The youngest stage observed presents the appearance of an ordinary *Cysticercus;* in older individuals the rudiment of the body of the future *Tænia*, considerably elongated, was seen. It had the form of a tube hollow from end to end, and its cavity communicates with the exterior by the orifice of the cysticercus. In still older

* Zool. Anzeig., XII. (1889) pp. 620–2.
† Comptes Rendus, cix. (1889) pp. 825–7.

individuals the tube becomes longer, narrower, and rolled on itself, and the whole length is now about 65 cm., with a diameter of one-fifth of a millimetre. All this development appears to be pure loss, for it is impossible that the head of *Tænia* can be evaginated, nor can the long tube, which has all the characters of the vesicle of a cysticercus, pass into the adult.

These remarkable peculiarities are as yet unknown in Cestodes; at first sight the great development of the body of the larva of *T. Grimaldii* may be compared to that of *T. crassicollis* of the Cat; but the difference between the two species is radical; in the latter there is no rupture of the receptaculum capitis such as, in the former, allows of the development of the body within the interior of the vesicle.

Several encysted worms have already been observed in Dolphins; the very curious *Stœnotænia Delphini* of Gervais has some resemblance to the cysticercus of *T. Grimaldii*; others have reported on the presence of true cysticerci, but all these descriptions, with the exception of those of *Phyllobothrium*, are not sufficient for us to be able to recognize the animals meant.

Monstrous Specimen of Tænia saginata.*—Dr. L. Trabut gives an account of a *Tænia saginata* with six suckers and of a trihedral form, taken from an officer who had been in Tonkin. Owing to its form it ceases to be a flat worm: a section across a ring is well represented by a Y; all the sexual orifices are situated along the edge which corresponds to the lower limb. The author considers that he has had to do with two worms half united by their male surfaces. Similar anomalies have been described in the case of other species of *Tænia* by Küchenmeister and others, but never before has the head been seen.

Swedish Cestoda.†—Herr E. Lönnberg gives a systematic account of Swedish Cestodes, diagnosing forty species, of which eight are new. He establishes two new genera, *Tritaphros* and *Ptychobothrium*, and gives a valuable list of 128 hosts with the parasites he has found in or on them, including not only Cestodes, but Trematodes, Nematodes, Acanthocephala, Crustaceans, and others.

δ. Incertæ Sedis.

New and little-known Rotifers.‡—Dr. W. B. Burn gives an account of *Stephanops intermedius*, a new species, which appears to stand between *S. lamellaris* and *S. muticus*, although he thinks it would be better to unite the three species. He also has some notes on *Œcistes umbella*, which he has found in a shallow pool on Tooting Common.

Echinodermata.

Echinodermata of Deep Water off the S.W. Coast of Ireland.§—Prof. F. Jeffrey Bell gives an account of the echinoderms collected in July last by the Rev. W. S. Green. The most important capture was that of six specimens of *Phormosoma placenta*. The author has been able to

* Arch. Zool. Expér. et Gén., vii. (1889) pp. x. and xi.
† Bihang Handl. K. Svensk. Vet.-Akad., xiv. (1889) pp. 1–69 (2 pls.).
‡ Science-Gossip, 1889, pp. 179–81.
§ Ann. and Mag. Nat. Hist., iv. (1889) pp. 432–45 (2 pls.).

show that the Drs. P. and F. Sarasin were incorrect in regarding the great development of the organs of Stewart as a characteristic of the Echinothuriidæ,* for in *Phormosoma* these organs may be altogether absent, or small vestiges may be present in some only of the rays. The muscles, which were described as dividing the test into a number of compartments, and as causing the vermicular motions of *Asthenosoma urens*, are also absent from *Phormosoma*, and are poorly developed in *A. pellucidum*. *Astrogonium greeni* is a new species, as is *Holothuria aspera*, and both, like *Phormosoma*, come from 1000 fathoms. *Antedon bifida* was found 150 fathoms lower than the 100 fathoms, already recorded as its greatest depth. *Nymphaster protentus*, described by Sladen among the Starfishes of the 'Challenger,' is an addition to the British deep-water fauna. *Echinus microstoma*, which was incompletely described by Wyville Thomson, is refigured, and measurements of it are given; some of the characters of *E. elegans* are discussed. An account is given of the variations presented by a number of specimens of *Spatangus raschi*, and it is pointed out that in discussing the question of the utility of specific characters we must exercise the greatest caution in the selection of the points of structure which we use as such marks. To such a question, and to the allied one, how far are characters that vary within considerable limits to be so used as specific, the answers that may be given must be tentative, and not dogmatic.

Comatulæ of Mergui Archipelago.†—Dr. P. H. Carpenter describes the six species of Comatulæ collected by Dr. John Anderson in the Mergui Archipelago. Five belong to the genus *Antedon*, and of these *A. Andersoni* is alone new; it belongs to what Dr. Carpenter has called the *elegans*-group but differs from known representatives in being bidistichate and not tridistichate, and in not having a well-plated disc. It is remarkable for the rarity of the syzygies in the arms; were the species fossil and the lowest portions of the arms alone preserved, and that badly, it would be possible to miss these unions altogether. The author suspects, therefore, that Walther's attempt to establish the absence of syzygies as a diagnostic character of *Solanocrinus* is partly due to a generalization in imperfect material. *Actinometra notata* sp. n. is described as a fine species allied to *A. paucicirra*, but differing from it in always having palmars, and sometimes twice as many arms. There is a very remarkable, and at present inexplicable, distribution of the grooves, for though all the arms are grooved, the ambulacrum from the left posterior angle of the peristome comes to a sudden ending on the disc, immediately after its first bifurcation; all the ambulacral grooves of the corresponding ray are connected with the single groove-trunk which comes round the right side of the disc. This abnormal arrangement does not seem to be accidental, but it may be due to parasitic growths.

Echinoidea of Mergui Archipelago.‡—Prof. P. M. Duncan and Mr. W. Percy Sladen report on the six species of Echinoids collected by Dr. John Anderson. All are known; and the most remarkable points are that all the regular forms belong to the family Termopleuridæ, and there

* See this Journal, 1888, p. 956.

† Journ. Linn. Soc., xxi. (1889) pp. 304–16 (2 pls.).

‡ T. c., pp. 316–9.

is not one representative of the nine genera lately recorded by Prof. Jeffrey Bell from the Andaman Islands.

Asteroidea of Mergui Archipelago.*—Mr. W. Percy Sladen reports that the collection of Starfishes made by Dr. John Anderson contains several new as well as rare forms, while some of the known species show variations which are sufficient to impart a character to the collection as a whole. It is reasonable to expect that a number of new species may ultimately be found in the Mergui Archipelago. Of the twelve species lately enumerated by Bell from the Andamans, only one species occurs here, and of seven genera only two are represented. The new species described by the author are *Astropecten Andersoni*, *A. notograptus*, and *Nepanthia suffarcinata*.

New Formation of Disc in broken Arm of an Ophiurid.†—Dr. R. Semon gives a description of a specimen of *Ophiopsila aranea*, which appears to have many points of interest. At first it looks as though there was a small disc, and three small arms in continuity with the larger arms. The small arms and the disc give every sign of being quite young, while the two larger arms have the appearance of those of normal and older animals. Against the supposition that these two arms have had twice as intense a power of growth as the other three, we have to put the fact that the central disc is still immature. The author concludes that we have here a case of an arm which has been able to give rise to all the essential parts of an Ophiurid with the exception of the generative products. Were a case found in which these also were developed the creature would be an important element in the discussion of the problem of the continuity of germ-plasm.

Prof. H. Ludwig ‡ subjects this paper to severe scrutiny. He is not at all satisfied with the exactness of the figures given; he argues against almost all of Dr. Semon's points, one by one, and he concludes that the specimen described was a not quite adult *Ophiopsila aranea* which had lost its disc as far as the peristome, three of its arms, and the tips of the other two, and was now replacing all these parts by regeneration. By Dr. Semon's courtesy he had himself the opportunity of examining the specimen.

Holothurioidea of the 'Gazelle.'§—Dr. K. Lampert gives an account of the forty-one species collected during the voyage of the 'Gazelle'; among them seven species and one variety are new. Unfortunately this surveying vessel did not obtain any examples of the Elasipoda, as no very deep dredging was made.

Cœlenterata.

Cœlenterata of Canary Islands.‖—Prof. C. Chun gives a short account of a new species of *Perigonomus*, which he calls *P. sulfureus*. As a result of his dredging he is able to show that the most common Craspedote Medusa of the Atlantic, *Aglaura hemistoma*, is essentially a

* Journ. Linn. Soc., xxi. (1889) pp. 319–30 (1 pl.).
‡ Jenaisch. Zeitschr., xxiii. (1889) pp. 585–94 (1 pl.).
‡ Zool. Anzeig., xii. (1889) pp. 454–7.
§ Zool. Jahrb., iv. (1889) pp. 806–58 (1 pl.).
‖ SB. K. Preuss. Akad. Wiss. Berlin, 1889, pp. 524–6.

surface form. The complete absence of Rhizostomata from his collections is striking, though fishermen say that they abound in July and August. Two new Cydippids were found, one of which is the type of a new genus which it is proposed to call *Ute*, while the specific name is *cyanea*. Sexually mature examples are not more than three to four mm. across. Although not common, it is constantly found throughout the winter. Young examples are devoid of the blue pigment which gives the specific name to the adult. The other new form is called *Hormiphora palmata;* it appears to be allied to the Mediterranean species *H. plumosa*.

Alcyonaria of the 'Challenger.'*—Professors E. P. Wright and T. Studer have issued their report on the Alcyonaria, other than the Pennatulida, collected during the voyage of the 'Challenger.' The classificatory views of Prof. Studer have already been explained in this Journal.† In all 189 species are described, 133 of which were forms already known. As the record of deep-sea Alcyonaria is still very incomplete, the authors deem it premature to draw any conclusion from them. Some of the species described are of remarkable beauty; such, for example, are *Dasygorgia cupressa*, and the species of *Stenella* and *Primnoisis*; the largest number of new forms appears to be in the genus *Spongodes*.

Actiniaria of the Bahamas.‡—Dr. J. P. M'Murrich gives a systematic and anatomical account of the Actiniaria of the Bahamas. One of the most striking characters of *Aiptasia annulata* is the occurrence upon the tentacles of a number of elevated bands; these are due to the thickening of the ectoderm only, the mesoglœa taking no part in their formation; they contain a number of nematocysts. In *Discosoma anemone*, on the other hand, the elevations on the column are produced by solid conical outgrowths of the mesoglœa, while the ectoderm which covers them is quite undifferentiated, and resembles in structure that which covers the walls in the intervals between them. Several specimens of this species were obtained in various stages of division. In the endoderm of *Rhodactis Sancti Thomæ* numerous cysts were found imbedded, measuring about 68 μ in length by 27 μ in breadth, and looking almost like encysted nematode parasites; they were found on examination to be nematocysts. *Heteranthus floridus* was observed in the process of fission; in one case the only evidence of it was the presence of two distinct peristomial elevations, each with a mouth, upon the disc, and a crowding of the rows of disc tentacles on the portion of the disc common to the two mouths. Several new species are described in this memoir.

The author was much struck by the resemblance which the Actiniarian fauna of the Bahamas presents to that of the Pacific, and its decided difference from that of the eastern coast of America. The occurrence of *Lebrunea neglecta* in shallow water in the West Indies is of considerable interest in view of the fact that the other members of the Dendromelinæ occur, so far as is known, in deep water—1375 and 2160 fathoms—off the coast of Chili. The author thinks that it is not so much the absolute temperature which limits the distribution of animals as the exposure to great, or more or less sudden variations.

* 'Challenger' Reports, xxxi. (1889) No. lxiv., 314 pp. (43 pls.).
† 1888, p. 237.
‡ Journal of Morphology, iii. (1889) pp. 1-80 (4 pls.).

Cerianthus borealis.*—Dr. D. C. Danielssen first described this species in 1838, but in deference to the opinion of his colleague the late Dr. Koren, he has long considered it as synonymous with *C. Lloydii*. Now, however, having had the opportunities of further studying the true *C. Lloydii* he reverts to his original view as to the distinctness of the two species. He now gives a full description of *C. borealis*. The bilateral symmetry noticed in some other species of this genus is apparent also in the northern form, where the bilaterality is internal as well as external.

The ectoderm contains an extraordinarily large number of nematocysts; when many are extruded the surface of the body has quite a fungoid appearance. In addition to the nematocysts there are a large number of unicellular clubshaped mucous glands, the efferent ducts of which are of some length. The clear fibrillar area lying beneath the ectoderm has been rightly regarded by Profs. O. and R. Hertwig as a nervous structure; under high powers its median part is seen to consist of a large number of nerve-fibrils, from which, on one side, there are given off many nerve-fibres; these form plexuses, and become lost in the muscular layer; on the other side there are ganglionic cells which have their broad ends turned towards the layer of nerve-fibrils. The nerve-cells have a large nucleus which is surrounded by a rather dark, finely granular protoplasm, and they give off one or more processes which form anastomoses, and are lost in the cylinder-cells of the ectoderm.

Below the nervous apparatus there is a well-developed muscular layer, consisting of transverse and longitudinal muscles, the former of which are external to, and more delicate than the latter; the two layers cross one another. The layer of connective tissue is very thin and homogeneous, and on its inner face there is a thin layer of circular muscles which is lined by endothelium.

There are eight pairs of septa, which are all complete, and of which two may be regarded as directive; between the digestive tract and the body-wall there is a large, unpaired, ventral chamber. All the septa are formed of a pretty thick supporting membrane, and all have mesenterial filaments and gonads connected with them. The sexes are separate, and the gonads are quite special in character.

The female organs form one or more round capsules which are separate from, and may be some distance from one another. The capsule commences as a protoplasmic thickening, which becomes broader at its base; only one egg is developed in each capsule, and, when it becomes free by the bursting of the capsule, it remains between the lamellar prolongations thereof; in this position it is, probably, fertilized. The testicle is in the form of a snake, and consists of a large number of sausage-shaped cæca, which are attached in groups to a membrane of connective tissue. Connected with the testicles are many nematocysts, which may either have the form of those described by Heider, or may be more elongated and have a thicker capsule. The male would appear to be smaller than the female, and to have a smaller number of tentacles.

The digestive tube is cylindrical; its inner wall is produced into well-developed longitudinal folds and is marked by two grooves, the

* Bergens Museums Aarsberetning for 1888 (1889) No. 1, 10 pp. (1 pl.).

lower of which is alone visible to the naked eye. The epithelium consists of short ciliated cylindrical cells in the grooves, while the cylindrical cells of the side-walls are longer. The author concludes with a technical diagnosis of this interesting species.

Antipathidæ of Bay of Naples.*—Herr G. v. Koch finds five species in the Bay of Naples, all of which belong to the genus *Antipathes*, and exhibit in common a number of essential characters, which are briefly described. Very little is known of the biology of these colonies of polyps, owing to the difficulty of keeping them alive for any length of time in an aquarium; as to the mode of growth of the colonies, more has been made out by comparative methods than by direct observation. In all the species examined by the author, there are numerous branches and twigs on which smaller polyps often alternate with those of normal size; these smaller forms are younger. If they are followed through all the stages of their development it is seen that they commence as tubular prolongations of the larger polyps, and that they push out two, four, and then six tentacles; while this is being effected the larger septa and the œsophageal tube are laid down, and they gradually become normal polyps. The species described in the present paper are *A. glaberrima* Esper, *A. gracilis* sp. n., *A. subpinnata* Ellis, *A. larix* Esper, and *A. aenea* sp. n.

Method of Defence among Medusæ.†—Mr. J. W. Fewkes draws attention to a method of defence among Medusæ, which consists in discolouring the water by the emission of coloured pigment from certain chromatic cells on the bracts; these cells are related to, and are perhaps homologous with, the nematocysts in other genera of the groups in which they exist. Their presence has been observed in only one or two genera of Siphonophora. The known facts appear to be:—(1) Certain Agalmidæ, Forskaliidæ, and Apolemiidæ discharge a coloured fluid from their cystons, or hydrocysts with "mouths." This fluid is regarded as an excretion, and is supposed by Haeckel to be the means of protection, just like the sepia of the Cephalopoda. (2) *Agalma* itself has pigment-glands on the bracts, which discharge their contents when the covering-scales are broken from the stem; this discharge probably takes place on simple irritation. (3) Certain Hippopodiidæ and one Calycophore are known to change colour somewhat on irritation. (4) *Nanomia* has a prominent pigmented "oil-globule" at the base of the cyston, which has never been seen to discharge its contents. Our ignorance of the physiology of Jelly-fishes is so great, that we can at present hardly go further than this, though it is obvious that a number of interesting questions easily arise.

Porifera.

Fresh-water Sponges of Florida.‡—Mr. E. Potts gives an account of some fresh-water sponges which are of interest on account of the unusual situations and circumstances in which they were found. Most had grown on the stem of coarse grasses, where they formed spindle-

* MT. Zool. Stat. Neapel, ix. (1889) pp. 187–204.
† Ann. and Mag. Nat. Hist., iv. (1889) pp. 342–50.
‡ Trans. Wagner Free Inst. of Science, ii. 3 pp. (separate copy).

shaped masses one to four inches in length. They are temporarily submerged in salt water, and may afterwards have to undergo desiccation for weeks or months. They may be regarded as forms of *Meyenia fluviatilis*, of which species there may be a number of varieties; the specimens in question were remarkable for an unusual abundance of gemmules. Mr. Potts also gives an account of a new species of *Spongilla*—*S. Wagneri*—clearly allied to the cosmopolitan *S. lacustris*; it is to be distinguished on the grounds that it was found incrusting such marine organisms as barnacles and the calcareous tubes of *Serpulæ*, and from the "unprecedented multitudes of its dermal spicules." It has the singular habit of hiding away its gemmules within the barnacle or among the convoluted stems of the *Serpulæ*; the spicules of the gemmules are more like those of *S. fragilis* than those of *S. lacustris*.

Two New British Sponges.*—Mr. R. Hope describes two new species of British Sponges. *Microciona strepsitoxa* was found on the flat valve of a *Pecten*; of the microsclera the toxa is twisted in a manner quite unknown in other species of the genus. The other new form, which receives the specific name *echinata*, is referred with some doubt to the genus *Trachytedania* of Ridley.

Protozoa.

Fresh-water Heliozoa.†—The first part of Dr. E. Penard's memoir deals, as may be supposed, with *Actinophrys sol.* He does not believe that the contractile vacuole communicates with the exterior, and brings forward facts in support of his contention. The pseudopodia have a very different structure from those of Heliozoa with an external skeleton; in the latter they are formed by extremely long and delicate filaments of the same thickness throughout, and not provided with any rigid internal support, while in *Actinophrys* there is a rigid axial rod and a finely granular layer of protoplasm. This protoplasm is derived from that of the ectosarc, and varies in quantity from one moment to another; the axial filament is almost always invisible; it is remarkable for sometimes dissolving completely, and that by a process which is difficult to ascribe to anything else than the will of the animal.

As a rule, *Actinophrys* is immobile, or moves very slowly; if, however, it is stimulated by a bright light, it moves much more rapidly. Although it always surrounds its prey by a layer of protoplasm, the manner in which it captures it varies with the size of the animal. If it be very small, a piece of very clear and very delicate protoplasm is rapidly produced from the ectosarc and takes the form of a wide-necked urn; this curves round and then completely incloses the prey, which is gradually drawn into the ectosarc.

If the prey be larger, say a free *Vorticella* striking against the pseudopodia, the *Vorticella* contracts and the pseudopodia which are in contact with it become amœboid and draw it towards the ectosarc, while the *Actinophrys* begins to surround the prey with its own substance in the form of a spider's web. While this is going on, processes of the ectosarc mount around the *Vorticella*, using the base of the nearest pseudopodia

* Ann. and Mag. Nat. Hist., iv. (1889) pp. 333–42 (1 pl.).
† Arch. de Biol., ix. (1889) pp. 123–83 (2 pls.).

as a ladder along which they creep; the protoplasm advances on both sides of the prey, till at last it completely incloses it in its middle. In both cases the author observed what he calls a halo round the prey; in the former it is the surrounding liquid, imprisoned with the prey between the walls of the vacuole; in the latter it is, partly at any rate, due to a secretion of the animal. When the prey is about as large as *Actinophrys* itself there is no halo, and the mode of prehension is somewhat different.

This organism appears to have acquired in the struggle for existence a place quite as advantageous as that of Rhizopoda with solid coverings, for on occasion its pseudopodia function as true spines, and it is consequently left unmolested by Rhizopods, Infusoria, and Rotifers, while, on the other hand, it makes considerable ravages among the last two of these groups.

The nucleus is quite unlike that which one is in the habit of seeing in the lower animals, for it has a vesicular structure. There is an external enveloping membrane which bounds a clear and apparently liquid mass, which itself surrounds a nucleus that is either rounded or has a slightly irregular contour. The author discusses the reasons for and against the view that the nuclear capsule is not part of the true nucleus, and decides in favour of the view that it is not.

Discussing the phenomena of reproduction, M. Penard points out that young examples differ a good deal among themselves; some are exactly like the adult, others have no vacuoles, the ectosarc forms a definite border, and the pseudopodia are almost always very fine, and much elongated; others have a non-vacuolated ectosarc which is not distinguishable from the endosarc, very short pseudopodia, and a well-marked body-contour; others differ from these last in having the pseudopodia fine and very long. In others, lastly, there are large rounded vacuoles around the nucleus, and the pseudopodia are very fine and much elongated or wanting. The author differs from Gruber in stating that the young examples always have a distinct nucleus; the error of Gruber is explained by the supposition that he has mistaken specimens of *Ciliophrys*, which look like young *Actinophrys*, but have a very obscure nucleus.

The description given by Bütschli of the mode of formation of colonies would appear to be correct. A very interesting phenomenon is that which is called "gélification"; the whole of the colony becomes transparent, and the ectosarc forms a hyaline mucilage around the clarified endosarc. If the formation of colonies has nothing to do with the direct reproduction of the individual, it is at least useful as infusing new forces into the animal; the agglomerated individuals fuse so closely with one another, and their protoplasm anastomoses so completely, that when a specimen separates it must carry away with it part of the general mass, while leaving behind a little of its own.

Division certainly occurs, and is perhaps less rare than it appears, for it is effected very rapidly and in darkness. In conclusion, the author has some observations on zoospores, budding, and encystation. The author agrees with Brandt that certain *Saprolegniæ* parasitically infest *Actinophrys*, and he gives a short account of his own observations on them.

Foraminifera of Deep Water off the S.W. Coast of Ireland.*—Mr. Joseph Wright gives a list of the species of Foraminifera dredged in 1000 fathoms during Mr. Green's recent expedition. Among the forms noted as very rare are *Biloculina sphæra* and *B. elongata*, *Planispirina contraria*, *Cornuspira carinata*, *Astrorhiza arenaria*, several species of *Bulimina*, and others.

Cytoplasm and Nucleus in Noctilucæ.†—M. G. Pouchet, who has already shown that by abundantly feeding Noctilucæ one may produce in them in a few days cellular segmentation and, later, gemmation, has continued his observations. The plastic cytoplasm is not hyaline, but uniformly granular, the granulations being all of the same diameter and refractive power, and separated by equal distances from one another. It always lies near the nucleus, and the latter is somewhat different from that of forms already known. The chromatin seems to be formed of two substances, which, perhaps, correspond to the microsomes and hyaloplasm dissolved in one another. During gemmation, and as the nuclei multiply, the mass of chromatin increases absolutely, but it would seem that the proportion of chromatoplasm increases, from what is shown by the more and more vivid coloration of the segmented nuclei. In ends which have become free, the spherical nucleus is completely and uniformly coloured by methyl-green. At no time and in no stage do *Noctilucæ* appear to have nucleoli.

New Sporozoon in Vesiculæ seminales of Perichæta.‡—Mr. F. E. Beddard has observed a remarkable Gregarine in the vesiculæ seminales of a species of *Perichæta* from New Zealand, in which they were present in crowds. In the youngest stage this Gregarine has a spherical body with one or two long processes. If there are two, they are placed at opposite poles. There is a delicate cuticle, and ectoplasm and endoplasm can be distinguished. In the next stage they are, though larger, similar in form. The granules of the endoplasm are, for the most part, large and oval. The endoplasm is especially thick in the processes of the body. The cuticle is raised into fine ridges which run obliquely to the long axis. In this stage, and in the last, multiplication by fission occurs. A swelling at the extremity of one of the processes gradually grows, developes a process at its other free extremity, and becomes separated as a new individual. In the third stage the Gregarine is covered by a cyst-membrane consisting of a fibrous substance, in which numerous nuclei are imbedded. In this stage sporulation occurs, commencing by a rapid division of the at first single nucleus. Karyokinetic figures are formed during the division of the nucleus. The protoplasm also divides, but not so rapidly as the nucleus.

* Ann. and Mag. Nat. Hist., iv. (1889) pp. 447–9.
† Comptes Rendus, cix. (1889) pp. 706–7.
‡ Zool. Jahrb., iv. (1889) pp. 781–92 (1 pl.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.

(1) Cell-structure and Protoplasm.

Behaviour of Vegetable Cells to a very dilute Alkaline Silver-Solution.*—Returning to this subject, Herren O. Loew and T. Bokorny give the following as the general result of a number of fresh experiments, chiefly on *Spirogyra*.

The reduction of an extremely dilute alkaline silver-solution by vegetable cells does not depend on the presence of a reducing substance soluble in water, but on a reaction of the albumen of living cells. The failure of this reduction in dead cells, or in those killed by heat, acids, &c., is not the result of the exosmose of a reducing substance, but of a chemical change in the albumen. The albumen of living cells coagulates from the fluid parts by the action of many bases, in the form of globules, for which the authors propose the name *proteosomes;* they have an energetic reducing action on very dilute alkaline silver-solutions; and it is on their formation that the direct reaction of living cells with alkaline silver-solutions depends. Proteosomes cannot be produced in dead cells.

A silver-solution free from ammonia can be obtained by adding to a litre of distilled water 0·01 gr. of silver nitrate, and 5–10 ccm. of saturated lime-water. This reagent gives essentially the same results with algæ free from tannin and with those which contain it.

Doubly-refractive Power of Vegetable Objects.†—Prof. S. Schwendener replies to the objections of Ebner and C. Müller against his previously published views on this subject. The experiments of the first-named observer were, he states, made on fluids rather than on solids.

(2) Other Cell-contents (including Secretions).

Green Colouring-matter in Buried Leaves.‡—Mr. W. Thomson describes a bed of leaves still retaining a distinct green colour, found at a depth of 21 feet below the surface when digging for the Manchester ship-canal, which must have lain in the same position certainly for some centuries.

Dr. E. Schunck § has determined this colouring-matter to be modified chlorophyll resulting from the action of acids on true chlorophyll.

Localization of Tannin.‖—Herr M. Büsgen states that in some plants tannin is present even in the seed, although in most it is not found

* Bot. Centralbl., xxxix. (1889) pp. 369–73; xl. (1889) pp. 161–4, 193–7. Cf. this Journal, 1888, p. 244.

† SB. K. Preuss. Akad. Wiss., xviii. (1889) pp. 233–44. Cf. this Journal, 1887, p. 981.

‡ Mem. and Proc. Manchester Lit. and Phil. Soc., ii. (1889) pp. 216–9.

§ T. c., pp. 231–3 (1 fig.).

‖ Jenaisch. Zeitschr. Naturw., xvii. (1889). See Bot. Centralbl., xxxix. (1889) p. 318.

till after germination. It then occurs in the primary meristem and cambium, especially at the apices of the roots, and at the spots where the secondary roots are being formed; in the older parts it often disappears entirely. The primary tannin (in Kraus's sense) may be formed in the same cells and groups of cells as the secondary, as, for example, in the vascular-bundle-sheath and the epiderm. The young cork-cells often contain a rather large quantity of tannin, which disappears later, and without being transferred elsewhere. When vessels are formed, the tannin disappears with the living protoplasm. In the pith, the cortical parenchyme, and the collenchyme, the tannin often decreases in quantity, but without the protoplasm also disappearing. There appears to be some analogy between tannin-sacs and bundles of raphides, but none between the former and starch.

Colouring-matter of the Cones of the Scotch Fir.*—Sig. L. Macchiati finds the colouring-matter of the cones of *Abies excelsa* to consist of a mixture of at least three pigments—a beautiful orange-red substance, insoluble in alcohol, ether, or chloroform, but very soluble in water, out of which it crystallizes; an uncrystallizable substance of a resinous nature; and a golden-yellow uncrystallizable substance soluble in water, but insoluble in alcohol, ether, and chloroform. In addition to these there is a substance of a waxy nature.

Function of Calcium Oxalate in Leaves.†—According to Sig. A. Alberti, secondary calcium oxalate is formed only in the assimilating cells, under the action of light; its accumulation is not promoted by transpiration. The crystals of calcium oxalate can be redissolved, when they fulfil a physiological function through their lime, not through their acid. This consists in aiding the transport of the carbohydrates from the assimilating tissue towards the reservoirs of food-material, and that of the nitrates, phosphates, and sulphates to the assimilating tissue. The lime, abandoned by the respective acids, which have furnished the elements for the formation of the more important plastic substances, combines with oxalic acid, which is a product of regressive metamorphosis.

(3) Structure of Tissues.

Mechanical Tissue-system.‡—Herr H. Mertins has investigated the function of the pores commonly found in the walls of bast-cells which are supposed to have a mechanical function only, and where, therefore, they could not serve primarily for the transport of food-materials. He finds that, as regards the apparent relationship of the mechanical tissue to the transport of sap, two types may be distinguished:—(1) A distinct stereome-cylinder which completely separates the conducting from the assimilating tissue; and (2) a stereome-cylinder with ribs projecting to the epiderm, outside of which is the assimilating tissue. The first type occurs only in certain Caryophyllaceæ; and it is in them only that the mechanical cells have a direct function in connection with the transport of food-material. As compared with the second type, the pores in the

* Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 423–7.
† Boll. Soc. Ital. Microsc., i. (1889) pp. 30–44. Cf. this Journal, 1889, p. 774.
‡ 'Beitr. z. Kenntniss d. mechanischen Gewebe-systems,' Berlin, 1889, 42 pp. See Bot. Centralbl., xl. (1889) p. 145.

bast-cells are more numerous and larger, especially on the tangential walls. In the other type, the transport is effected chiefly through mestom-bundles, sometimes through special cortical bundles, or by means of thin-walled parenchyme-cells; the bast-cells have but few and small pores.

Distribution of Laticiferous Tissue in the Leaf.*—Dr. D. H. Scott gives the result of observations on the course of the laticiferous tubes in a number of plants belonging to the Euphorbiaceæ, Artocarpaceæ, and some other natural orders. In the various species of *Ficus* no constant relation could be detected between assimilating and laticiferous tissue; but in some leaves the laticiferous cells appear to traverse all the tissues equally. It seems most probable that the laticiferous tubes are related functionally, as well as anatomically, to the secretory sacs of other plants.

Influence of the Symmetry of the Stem on the Fibro-vascular Bundles.†—Herr O. Lignier attempts to show that the course of the vascular bundles in the stem depends on the position of the leaves, because each bundle originates independently of the next at the base of the young rudiment of the leaf, and developes from above downwards as the internode increases in length. The lower end of the bundle then unites with the bundle-system of the internode next or next but one in age, applying itself laterally to an older bundle when the phyllotaxis is spiral, or forking when the phyllotaxis is verticillate, each fork uniting with a lateral bundle.

Anatomy of the Mulberry.‡—Prof. A. N. Berlese describes in detail the anatomical structure of the wood of *Morus nigra*, the present instalment being devoted to the root and the passage from root to stem. The root belongs to Janczewski's fourth group, in which the extremity of the central cylinder passes insensibly into the cortical zone, and the cortical zone into the cap, by means of a group of common initial cells. The peculiar excrescences of the root are described as being filled with a violet tissue which has been regarded by some writers as a mass of parasitic fungi, but which has been clearly shown to be the result of hypertrophy of the lenticels generated in the suberous tissue of the root.

Stem of Phytocrene macrophylla.§—Herr B. L. Robinson describes in detail the peculiarities of the anatomy of the stem of this tree from Java, and especially of the peculiar wedges between the bast-plates, characterized by their looser and softer texture, and by the presence of tracheïdes, and of the very large vessels composed of short cells.

Increase in thickness of the Stem of Abrus precatorius.‖—Herr J. H. Wakker describes the abnormal mode of increase in thickness of the stem in this plant, which he regards as belonging to Van Tieghem's group characterized by the possession of tertiary fibro-vascular bundles

* Ann. of Bot., iii. (1889) pp. 445–8. Cf. this Journal, 1888, p. 72.
† Bull. Soc. Linn. Normandie, ii. (1889) 15 pp. See Bot. Centralbl., xl. (1889) p. 114.
‡ Atti Soc. Veneto-Trentina Sci. Nat., x. (1889) pp. 256–73 (2 pls.).
§ Bot. Ztg., xlvii. (1889) pp. 645–57, 661–72, 677–86, 693–701 (1 pl. and 1 fig.).
‖ T. c., pp. 629–38 (1 pl.).

in the secondary cortex, and to the second half of this group. The course of the tertiary increase in thickness is, however, somewhat more simple than that described by Van Tieghem.

(4) Structure of Organs.

Structure of an Assimilating Parasite.*—Herr H. Hackenberg describes the vegetative structure of a phanerogamic parasite, *Cassytha americana*, belonging to the Lauraceæ. The slender stems are leafless, like those of *Cuscuta*, and attach themselves to the host by means of a somewhat similar structure, but contain abundance of stomates, and are distinguished by the remarkable peculiarity of the assimilating tissue of the cortex being very fully developed. In this respect it resembles the chlorophyllous parasites belonging to the Santalaceæ and Rhinanthaceæ, which are, however, mostly root-parasites. But its mode of life is that of *Cuscuta*. For when a haustorium has once been formed, all direct connection with the soil ceases; it lives on the sap of the host, which it gradually kills; the lower part of the parasite itself perishes, while the upper portion continues to develope.

Membrane of Pollen-grains.†—M. L. Mangin gives the following as the result of his investigations on the membrane of ripe pollen-grains:—(1) The membrane is differentiated into two layers: the one external and cutinized, the extine; the other internal and always present, the intine. (2) The intine, of which the structure is sometimes complex, is always formed of a combination of cellulose and pectic compounds; but the cellulose is limited to the internal face of the intine, and the pectic compounds form, nearly in a state of purity, the mass opposite the pores and hitherto considered as cellulose. In *Spartium junceum* the extine will be found to be composed of two layers: an internal cutinized zone, which is coloured yellow by alkalies; and this zone is clothed by a very thin colourless membrane, which is difficult to see. The intine also shows clearly two distinct layers. (3) When the membrane of the pollen-grain swells, it is the pectic compound which becomes soluble and absorbs water, and form a gelatinous mass, and later a viscid liquid. The cellulose does not take any part in this. (4) A callus which up to the present time was only known to exist in sieve-tubes has been found in a certain number of pollen-cells (Coniferæ, Cyperaceæ, and Juncaceæ), as an intercalary mass between the extine and the intine, and more or less mixed with substances composing this latter membrane. In *Carex riparia* the callus will be seen to be non-homogeneous; but it shows stratification, which is caused by cellulose and pectic substances forming bands parallel to the internal face of the mass.

Thickening-layers of Pollen-grains.‡—Herr A. Tomaschek has investigated the phenomena attending the growth of pollen-tubes, in the case of pollen-grains of *Colchicum autumnale* made to germinate on the cells of ripe fruits. He states that when the grains are made to germinate in nutrient solutions, the growth is so rapid that abnormal

* Verhandl. Natur. Ver. Preuss. Rheinl., xlvi. (1889) pp. 98–138 (2 figs.).
† Bull. Soc. Bot. France, xxxvi. (1889) pp. 274–83.
‡ Bot. Centralbl., xxxix. (1889) pp. 1–6 (11 figs.).

phenomena are frequently set up. In the course of its normal growth the membrane of the pollen-tube undergoes thickening of a very similar nature to that which has been observed in the bast-cells of the Apocynaceæ and Asclepiadeæ. This is effected neither by apposition nor by intussusception, but by the production of new masses of cellulose out of the protoplasm. The thickening is indicated by the silky refraction of the tube. It frequently takes the form of a number of caps formed successively within the apex of the tube. The separation of the protoplasm into distinct masses sometimes gives the appearance of a septated pollen-tube.

Morphology and Physiology of Pulpy Fruits.*—Mr. J. B. Farmer states that the morphology and physiology of the pulp of succulent fruits remains almost an untouched field. It is a fact worthy of notice that, while pulpy fruits are very common in certain natural orders, so much so as to constitute one of the ordinal characters, the morphological nature of the pulp itself may vary considerably within a very narrow limit of affinity. Amongst British plants the Caprifoliaceæ afford perhaps the best examples of this; thus, in *Lonicera Periclymenum* not only the pericarp and placenta become fleshy, but also the bracts and axis of the inflorescence; in the nearly allied *L. Caprifolium*, however, the succulent tissue is derived from the placenta and pericarp alone. Besides the extreme case of the honeysuckles and the more common forms of berries and drupes, there are some plants, as the rose and the strawberry, where the entire pulp is derived from the receptacle; in others the floral envelopes contribute the chief portion, as in *Hippophaë* and *Morus*. Another and more irregular source of pulp is the aril, as in the yew. Even in berries the relative parts played by the placenta and pericarp show great variety in different plants. Thus, in *Vitis* each furnishes about half, in *Solanum Dulcamara* the placenta, and in *Ligustrum vulgare* the pericarp provides almost the whole pulp.

The author then deals in detail with three forms of common occurrence which illustrate some of the varieties which are found in the nature and formation of pulp. In the ivy we have a plant where the pulp is mainly derived from the tissue of the carpels; and from the very first this tissue is clearly marked off from the peripheral cells which owe their presence to the activity of the meristem; since in the carpels the cell-divisions occur irregularly, and without definite order, except in the few layers destined to form the parchment-like endocarp. In the blackberry a portion of the pericarp only is devoted to the formation of pulp, the remainder undergoing modification to enable it to meet other and special requirements; while in *Solanum Dulcamara* we meet with a case in which the pulp owes its origin to two sources, being derived partly from the wall of the superior ovary, and partly from the tissue of the placenta. The author traces the formation of the pulp in all these three last cases.

Branching of Vegetative Axis and Inflorescence.†—Dr. J. Velonovsky describes the mode of branching of the axis of *Taxodium distichum* (sympodial), *Luzuriaga radicans* (Smilacineæ), and *Myrsiphyllum angus-*

* Ann. of Bot., iii. (1889) pp. 393–413 (2 pls.). Cf. this Journal, 1889, p. 244.
† SB. K. Böhm. Gesell. Wiss., 1888, pp. 365–76 (1 pl.).

tifolium (Asparageæ), of the cone of *Sequoia sempervirens*, and of the inflorescence of *Elvira biflora* (Compositæ). The axis of the male inflorescence of *Sequoia sempervirens* appears to present normally an example of dichotomous forking. The inflorescence of *Elvira* exhibits the remarkable singularity of being reduced to about three flowers, the receptacle being completely suppressed; the mode of development is cymose.

Comparative Anatomy of Bracts, Leaves, and Sheathing Leaves.* —M. L. Dufour shows that:—(1) The structure of the floral bracts is nearly always different from that of the ordinary leaves; (2) in the same leaf, or in leaves of various origin on the same plant, different types of structure may be found; (3) the structure of the sheath is nearly always different from that of the lamina; (4) there is not an invariable type of structure in leaves; the structure of the leaf depends essentially upon its mode of origin.

Laminar Enations from the Surfaces of Leaves.†—Dr. A. Ernst describes two cases of laminar enation. In the first it was found that on the dorsal surface of two of the leaves of a specimen of *Anthurium crassinervium* there were quite a number of curious enations midway between the primary nerves; and in the second, a leaf of *Mangifera indica* had on its under surface a secondary leaf growing from the midrib. The author states that we have here a case of fission; but as to its primary cause or causes, he does not offer any suggestions.

Apparatus to demonstrate the Mechanism of Turgidity and Movement in Stomates.‡—M. L. Errera describes a very simple apparatus illustrating the mechanism in stomates. It is composed of a ball of caoutchouc, which is surrounded by a network of silk, and terminates at each end in a small rigid tube. The branches of a metallic support bifurcate and receive the tubes in question. One of the tubes is closed, the other carries a cock, and this cock can be opened and air injected; the caoutchouc ball distends and presses against the silk network, the cock is then turned, and the ball remains rigid and turgid. The above is comparable to a turgid vegetable cell. The author concludes by describing a slight modification of this apparatus, consisting of two crescent-shaped balls of caoutchouc touching at their extremities but free in the middle, which may be compared to the two cells of a stomate.

Hairs of Labiatæ and Borragineæ.§—Herr C. Schmidt finds the hairs of the Borragineæ very uniform in character, stiff and sharp-pointed, with an elevated basal cushion formed from epidermal cells. Glandular hairs are comparatively rare; branched hairs or secreting glands do not occur in the order. The hairs of the Hydrophyllaceæ closely resemble those of the Borragineæ.

In the Labiatæ, on the other hand, a great variety occurs in the nature of the hairs, characteristic of the suborders, and even in some

* Bull. Soc. Bot. France, xxxvi. (1889) pp. 304–8.
† Ann. of Bot., iii. (1889) pp. 439–42.
‡ Bull. Acad. R. Sci. Belgique, xvi. (1888) pp. 458–72 (1 pl.).
§ 'Vergleich. Unters. üb. d. Behaarung d. Labiaten u. Borragineen,' Rybnik, 1888, 68 pp. See Bot. Centralbl., xxxix. (1889) p. 35.

cases of the genera and species. Glandular hairs are exceedingly common, often almost entirely replacing all other kinds; and they are very often accompanied also by oil-glands. Many species have branched hairs; in *Lavandula* they are stellate. The interior of the flower is very often provided with hairs of various kinds, which are concerned either with protection from the attacks of insects or with the carriage of pollen.

Hairs of Labiatæ, Scrophulariaceæ, and Solanaceæ.*—Herr F. A. Hoch describes the hairs characteristic of the different suborders of Labiatæ, which vary greatly. In the Scrophulariaceæ there is not the same amount of variation, the prevalent form being simple multicellular hairs with smooth or warty cell-wall. The Orobanchaceæ with their glandular hairs stand by themselves. In the Solanaceæ a great variety exists in the form of the hairs; the Atropaceæ are distinguished by the absence of sessile glands, and the occurrence of shortly stalked capitate hairs.

Underground Scales of Lathræa.†—M. M. Hovelacque describes the structure and development of the underground scaly leaves of *Lathræa.* When mature the margins and apex are recurved so as completely to cover the under side of the leaf with the exception of the basal region. From the latter a small opening leads to an anterior space into which posterior cavities open on all sides; all the chambers are clothed with the epiderm of the under side of the leaf, which is covered with numerous capitate hairs and peltate glands, but has no stomates. A single vein passes from the stem into the scale, where it branches.

Structure of Königia.‡—Herr O. Juel elucidates several obscure points in the structure of *Königia islandica* (Polygonaceæ). The phyllotaxis he describes as a modification of the decussate, in which the two leaves of some pairs are separated by an internode. All intermediate stages occur between this and the normal decussate phyllotaxis. In the development of the flowers the stamens originate earlier than the perianth-leaves. The inflorescence is cymo-botryoid, not differing in any essential point from that which occurs in typical Polygonaceæ.

Root-tubercles of Leguminosæ.§—Herr A. Prazmowski reviews the present state of our knowledge on this subject, and gives the results of a fresh series of experiments, chiefly on *Pisum.*

The tubercles are not normal structures, but are formed only as the results of infection, the infecting organisms being bacteria, as determined by Beyerinck; and the formation of tubercles takes place only when the root is young, the mature organs not being liable to infection. The bacteria perforate directly the young cell-wall, and thus enter the root-hairs and the epidermal cells of the root, where they multiply at

* 'Vergleich. Unters. üb. d. Behaarung unserer Labiaten, Scrophularineen u. Solaneen,' Freiburg-i.-B., 1888. See Bot. Centralbl., xxxix. (1889) p. 124.

† Bull. Soc. d'Etud. Scient. Paris, xi. (1888) 5 pp. See Bot. Centralbl., xxxix. (1889) p. 84. Cf. this Journal, 1889, p. 89.

‡ SB. Naturv. Studentsällsk. Upsala, April 19, 1888 (2 figs.). See Bot. Centralbl., xl. (1889) pp. 5 and 36.

§ SB. K.K. Akad. Wiss. Krakau, 1889. See Bot. Centralbl., xxxix. (1889) p. 356. Cf. this Journal, 1889, p. 246.

the expense of the protoplasmic contents of the cell. At the apex of the root-hairs they form botryoid colonies, which surround themselves with a refringent membrane, and coalesce with the cell-wall of the root-hair. From this period until the tubercle is fully formed, the growth of the bacterium-tube resembles that of a fungus-hypha, penetrating the epiderm and the cortex of the root even as far as the endoderm of the central cylinders. The neighbouring cells now begin to increase by division; while the bacterium-tubes branch abundantly, and form the "bacterioid tissue." The position of the tubercle is not a definite one, but may be opposite either the xylem of the central bundle, or the phloem, or between the two.

The relation between the root and the bacterioid organism is a true symbiotic one, each developing more vigorously at the expense of the other; though whether the additional supply of nitrogen is derived, as Hellriegel supposes, directly from the atmosphere or not, the author has been unable to determine. Finally, the contents of the bacterioid cells become gradually absorbed by the host-plant; this taking place with greater energy in inverse proportion to the amount of nitrogen supplied from the soil. The host-plant, therefore, is the stronger of the two symbiotic elements.

Tubers of Hydrocotyle americana.*—Mr. T. Holm describes in detail the vegetative structure of this American marsh-plant, especially of the little-known tubers attached to the underground stolons. The plant has two kinds of vegetative propagation,—by these stolons which end in tubers, and by runners which creep along the surface.

β. Physiology.

(1) Reproduction and Germination.

Heredity and Continuity of Germ-plasm.† — Herr G. Liebscher describes a series of experiments on hybrid barleys, especially between the 2-rowed and the 4-rowed forms, from which he draws conclusions favourable to Weismann's theory of the continuity of the germ-plasm, at least as far as its substance is concerned; though its structure may be independent of this; the structure not determining the properties themselves, but only their manifestation or latency.

Pollination by Insects.‡—M. J. M'Leod describes the mode of pollination of a number of flowers belonging to the Belgian flora; and gives many particulars with regard to the relative importance of the part played by different classes of insects in the fertilization of flowers. The following is given as the order of importance:—Coleoptera, hemitropous Diptera (Syrphidæ, Conopidæ, Bombylidæ), Apidæ with long proboscis, Lepidoptera.

Fertilization of Gladiolus.§—M. C. Musset describes certain curvatures of the styles and filaments of *Gladiolus segetum*, in consequence of which, notwithstanding the extrorse dehiscence of the anthers, self-

* Proc. U.S. National Museum, 1888, pp. 455–62 (2 pls.).
† Jenaisch. Zeitschr. Naturw., xxiii. (1889) pp. 216–32.
‡ Bot. Jaarb. (Gent), i. (1889) pp. 19–20 and 100–23 (3 pls.). See Biol. Centralbl., ix. (1889) p. 257.
§ Comptes Rendus, cviii. (1889) pp. 905–6.

pollination is not only rendered possible, but is, as he believes, the ordinary mode of fertilization.

Fertilization of Glossostigma.* —Mr. C. W. Lee describes the peculiar structure of the pistil in *Glossostigma elatinoides*, a native of New Zealand. It forms a kind of hood over the stamens; and, when irritated, rises up and falls back upon the petals, leaving the stamens exposed. In about fifteen minutes after being disturbed, it resumes its original position. The author believes that the object of this contrivance is to favour cross-fertilization.

Pollination of the Barberry.†—Prof. B. D. Halsted describes the mode of pollination of *Berberis vulgaris*, which is very rarely, if ever, self-fertilized. Surrounding the rim of the cup-shaped stigma is a narrow belt of long stiff hairs, secreting abundance of an adhesive substance; and it is on to these hairs that the pollen is thrown when the valves of the anther are thrown back, and not the upper surface of the discoid stigma, which is covered with papillæ, and which only can incite the emission of pollen-tubes. To this surface the pollen-grains can be carried only by insects.

Irritability of the Stamens of Portulaca.‡—Prof. B. D. Halsted calls attention to the remarkable irritability of the stamens of the purslane, *Portulaca oleracea*, and *P. grandiflora*, which promotes the scattering of the pollen over the bodies of insects visiting the flowers.

Cultivation of the Pollen-tubes of the Primrose.§—To ascertain the cause of the greater fertility of "legitimate" as compared to "illegitimate" unions in the heterostylous species of *Primula*, Herr C. Correns has cultivated the pollen-grains in a solution of 20 per cent. sugar and 3 per cent. gelatin. He finds the measurements of the pollen-grains to agree nearly with those given by Darwin; the diameters of the short and long-styled forms being in the proportion of 10 : 7, the volume being therefore about 3 : 1. Contrary, however, to what has hitherto been stated, he found that the larger grains do not put out longer tubes than the smaller grains, though they are somewhat thicker; nor is there any difference of form and size in the papillæ on the stigmas of the two forms. The author was unable to find in the pollen-grains themselves any explanation of the greater fertility of "legitimate" unions.

Distribution of Seeds by Birds.‖—According to Herr W. O. Focke, the seeds of berry-bearing plants are not distributed by birds to the extent generally supposed; since they are usually voided in close proximity to the parent-plant. The species which appears to be most widely distributed in this way is the juniper; also to a less extent the following:—*Pyrus Aucuparia, Sambucus nigra, Rubus Idæus, Solanum Dulcamara, Frangula Alnus, Viburnum Opulus*, and the black-fruited species of *Rubus*.

* Trans. New Zealand Inst., xxi. (1888) pp. 108–9.
† Bot. Gazette, xiv. (1889) p. 201.
‡ Bull. Bot. Departm. State Agricult. College Iowa, 1888, pp. 65–6.
§ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 265–72.
‖ Abhandl. Naturw. Ver. Bremen, x. (1889) p. 140. See Bot. Centralbl., xl. (1889) p. 148.

Dispersion of Seeds in Excrement.*—Herr E. Huth gives a list of 100 flowering plants, the seeds of which are disseminated through the agency of birds and other animals. In the Tropics monkeys and bats play an important part in this respect.

(2) Nutrition and Growth (including Movements of Fluids).

Importance of Potassium for the Growth of Plants.†—Herr R. Lübke finds, from experiments on *Phaseolus multiflorus*, that, when supplied with only a very small amount of potassium-salts, assimilation and metastasis still go on, although the vegetative processes are greatly reduced in energy. *P. vulgaris*, grown in a nutrient solution containing no potassium, showed much greater vigour than when grown in pure water, metastasis, cell-division, and the growth of the organs still proceeding. Even the formation of reproductive organs takes place, and the seeds, though small, are capable of germination. The energy of growth of *Polygonum Fagopyrum* exhibited, under similar circumstances, much greater deterioration. The author concludes that potassium is not absolutely essential for any one function of the plant; but that it plays in the vital processes a part similar to other elements, such as nitrogen, phosphorus, or sulphur.

Multiplication of Bryophyllum.‡—Mr. B. W. Barton describes the mode of production of buds on the margins of the leaves of *Bryophyllum calycinum*. A growing point is first formed from a group of embryo-cells situated at the base of the notches of the crenate leaves; and the first sign of activity of the new bud is the protrusion of usually two roots. The plantlet arising from the bud attains considerable size while still attached to the parent-leaf, which appears to carry on the work of assimilation for the benefit of the offspring.

Power of Transplantation of Organs.§—Herr H. Vöchting has conducted a series of experiments for the purpose of determining whether a part of a plant will continue to grow when planted on another organ of the same kind. He finds that this is almost always the case, and even when planted on an organ of a different kind. From this he draws the conclusion that every part of the stem and of the root is polarized like the parts of a magnet; and that every living cell of the root and of the stem has an upper and lower, an anterior and posterior, and a right and left half; the latter being apparently constructed symmetrically.

Climbing Shrubs.‖—Herr H. Schenck describes the mode of climbing of a number of Brazilian lianes belonging to the orders Polygalaceæ, Leguminosæ, Hippocrateaceæ, and others, which he calls "twig-climbers." The climbing is effected by the young leafy lateral branches being sensitive on the side in contact with the support. These then twine several times, continue to grow and increase in thickness,

* Samml. Naturw. Vorträge (Berlin), iii. (1889) 35 pp.; and Huth's Monatl. Mitteil., vii. (1889) 21 pp. See Biol. Centralbl., ix. (1889) p. 263.

† Landwirth. Jahrb., xvii., pp. 887–913 (1 pl.). See Bot. Centralbl., xxxix. (1889) p. 351.

‡ Johns-Hopkins Univ. Circ., viii. (1889) pp. 38-9.

§ Nachricht. K. Gesell. Wiss. Göttingen, 1889, pp. 389–403. See Bot. Centralbl., xl. (1889) p. 112.

‖ Verhandl. Naturw. Ver. Preuss. Rheinl., xlvi. 1889 (S.B.), pp. 9-10.

and then put out lateral branches of a higher order which display similar properties.

Epinasty and Hyponasty.*—From observations made on a number of plants growing either naturally in the soil or in a clinostat, Prof. S. H. Vines has arrived at the conclusion that the changes in the position of the leaves of growing plants are due entirely neither to the action of light nor to that of gravitation, but are epinastic and hyponastic, i. e. are the result of an inherent tendency of one or the other surface of dorsiventral organs to grow faster than the other surface. The tendency of epinasty, or the more rapid growth of the upper surface, in leaves, is to bring the lamina into the vertical plane, the apex being directed downwards; while the tendency of hyponasty, or the more rapid growth of the under surface, is to raise the member so that its long axis approaches the vertical. The changes in the position of the leaves of *Mimosa*, and that of the petals of flowers on variations in temperature, he attributes in the same way to the action of epinasty and hyponasty acting in conjunction with light.

Ascent of Sap in Woody Stems.†—Dr. F. Fankhauser gives fresh proof of the accepted theory that the ascent of sap takes place chiefly in the xylem of the vascular bundles, and principally in its vessels, from which it is distributed to the parenchyme; to a less extent through the epiderm and supporting tissue. He adopts Sachs's imbibition-theory, and considers that neither root-pressure nor transpiration is necessary to account for the elevation of the sap.

The same principles are further applied ‡ to explain the large quantity of water found in the endosperm of grasses, especially of barley.

Conduction of Water.§—After a *résumé* of the results of the most recent investigations by others, Herr T. Bokorny describes a fresh series of experiments with a view to determine the tissue through which the ascent of sap takes place in woody plants. The general conclusion arrived at is that this is by no means constant, though the conduction takes place chiefly through the vascular bundles, both in woody plants with a closed woody mass, and in those in which the vascular bundles are distributed over a transverse section. In certain plants the collenchyme and the sclerenchyme and even the epiderm, may take part in this function. In the bundles themselves, the chief part is played by the xylem, though the movement takes place also, to a certain extent, through the thin-walled bast. In plants which have no true vascular bundles, such as mosses, the ascent takes place through the central bundle of the stem.

Conduction of Water in Wood.‖—Replying to Hartig's criticisms,¶ Herr A. Wieler adduces fresh arguments in favour of his view that the conduction of water does not take place indifferently through the whole

* Ann. of Bot., iii. (1889) pp. 415–37 (2 figs.).

† 'Beitr. z. Erklärung d. Saftleitung,' 14 pp. and 1 pl., Bern, 1889. See Bot. Centralbl., xl. (1889) p. 114.

‡ Allg. Zeitschr. f. Bierbrauerei u. Malzfabrikation, 1889, 4 pp. and 2 pls. See t. c., p. 115.

§ Biol. Centralbl., ix. (1889) pp. 289–303, 321–7.

‖ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 204–12. Cf. this Journal, 1889, p. 251.

¶ Cf. this Journal, 1889, p. 90.

of the alburnum in the trunk of trees, but chiefly through the last annual ring, which is in direct connection with the appendicular organs of the same year.

Transpiration.*—Herr O. Eberdt sums up the results of recent researches on this subject, confirming some of the conclusions by independent observations. The work is divided into the following chapters:—(1) Influence of light on transpiration; (2) Influence of the moisture of the air on transpiration; (3) Influence of heat on transpiration; (4) Influence of concussion on transpiration; (5) Influence of wind on transpiration; (6) Periodicity of transpiration.

γ. General.

Epiphytes.†—Prof. K. Goebel sums up the known facts with regard to the life-history of tropical epiphytes. At the end of the root there is formed an attachment-disc with root-hairs similar to that of the Loranthaceæ. In *Terniola* (Podostemonaceæ) the attachment to stones is effected by a "thallus" composed of coalesced dorsiventral branches. In *Clusia* and some species of *Ficus*, the aerial roots coalesce into a cylinder surrounding the stem of the host. The velamen of Aroideæ and Orchideæ is regarded by the author mainly as an organ of assimilation, the absorption of moisture being only a secondary function. In some Bromeliaceæ, as *Tillandsia usneoides*, the leaves absorb water directly through their surface, and the roots then often completely disappear. The absorption of water through the auricles of epiphytic Hepaticæ and by the leaves and stem of epiphytic ferns and flowering plants, and the accumulation of humus by the leaves of ferns specially constructed for the purpose, previously described by the author,‡ are now treated of more in detail.

Succulent Plants.§—In an exhaustive account of the structure and biology of succulent plants, Prof. K. Goebel describes the vegetation of the "catingas," in which the trees are bare of leaves during the dry season in the summer. The resistance of succulents to desiccation depends not only on their anatomical structure, but also on the mucilaginous character of their sap. Protection against animals is afforded either by mechanical means—the thorns of *Cactus*, or a coating of wax; or by chemical means—alkaloids, tannin, poisonous substances, or latex. Extrafloral nectaries occur in some species of *Cactus*.

Succulents may be classified into those with succulent leaves, and those with succulent stem. Of the former class, when the leaves resemble ordinary leaves, as in *Oxalis carnosa*, it is the upper epiderm which assumes the character of hydrenchyme or a reservoir of water; in other cases the hydrenchyme is surrounded by chlorophyllaceous cells. In Crassulaceæ the hydrenchyme is wanting.

Stem-succulents occur in the Euphorbiaceæ, Cactaceæ, and Ascle-

* 'Die Transpiration d. Pflanzen u. ihre Abhängigkeit v. äusseren Bedingungen,' Marburg, 1889, 98 pp. (2 pls. and 2 figs.). See Bot. Centralbl., xxxix. (1889) p. 257.

† 'Pflanzenbiologische Schilderungen,' Pt. i., Marburg, 1889, pp. 147-239 (3 pls. and 37 figs.). Cf. this Journal, 1889, p. 414.

‡ Cf. this Journal, 1888, pp. 90, 92.

§ Pflanzen-biol. Schild., Pt. i., Marburg, 1889, pp. 23–110 (4 pls. and 46 figs.).

piadeæ; the leaves are often greatly reduced, the chlorenchyme of the stem performing the function of assimilation; though some species of *Euphorbia* have quite normal leaves. In some species both of *Euphorbia* and *Mesembryanthemum*, the growing point is protected against desiccation by being deeply imbedded in the tissue of the stem. Many Cactaceæ have brittle branches which readily break off and are scattered by the wind; the seeds of the epiphytic *Rhipsalis Cassytha* are disseminated in the same way as those of the mistletoe. In some species, as *Cereus tuberosus* and *Euphorbia tuberosa*, the storage of water takes place in the root. The ribs of many Cactaceæ are the result of the coalescence of rows of papillæ.

Vegetation of Mud-Banks.*—Prof. K. Goebel describes the peculiarities of the vegetation of mangrove-swamps. The air-roots serve simply for support, the nutriment being absorbed through the mud-roots. A similar germination of the seeds while still within the seed-vessel to that of *Rhizophora* takes place also in *Aegiceras* (Myrsinaceæ), *Avicennia* (Verbenaceæ), and in *Crinum asiaticum* (Amaryllideæ); and the phenomenon may be compared to that in the epiphytic species of *Hymenophyllum*, *Pellia*, and *Fegatella*, where the first stages of germination take place within the sporange or sporogone. The aerial roots of *Sonneratia* and *Avicennia* † which grow erect out of the mud are respiratory organs.

Temperature of Trees.‡—Mr. H. L. Russell has conducted certain experiments upon the temperature of trees. Holes one-half inch in diameter were bored into the trees at equal heights from the ground, and thermometers were inserted in the borings so that the base of the bulb came in contact with the wood; the space about the thermometer was packed tightly with cotton-wool. An experiment made upon *Carya alba* gave the following result. The temperature of the tree, as a general rule, ranged higher than the outside with two or three exceptions, when the air temperature was higher during the warmer portions of the day. Comparative observations were made with the pine, larch, oak, poplar, and outside air, and in all cases the temperature of the pine was found to be considerably lower than any of the remainder (except during the latter part of the night and early morning). Presumably the thick coating of foliage has a tendency to prevent absorption of heat by the trunk. The conclusion arrived at by the author is that the direct absorption of heat is the main cause of the higher temperature of trees, and that it is largely dependent upon the character of the bark.

Cotton Fibre.§—Mr. T. Pray describes the structure of various cotton fibres. Fibres of the best Pernambuco cotton will be found to be rather flat and of the nature of narrow tape. The edges are not thickened, and there is little or no spirality in the fibres. The oil-deposits are few, and not very marked. Upland cotton is not strong and robust in appearance; the fibres are weak in their outline, not very well thickened on the edges, but the spirality is more noticeable. There

* Pflanzen-biol. Schild., Pt. i., Marburg, 1889, pp. 111–46 (1 pl. and 4 figs.).
† Cf. this Journal, 1887, p. 111. ‡ Bot. Gazette, xiv. (1889) pp. 216–22 (1 pl.).
§ Journ. Franklin Inst., cxxviii. (1889) pp. 241–57.

are some traces of oil-deposits, but it is of the same not clearly developed type. Upland Georgia cotton is beautifully developed, clean in outline, well formed, full of oil-deposits, and with very good spirality. The finest cotton raised anywhere in the world is the Mississippi delta cotton; beautiful in its structure, perfect in its developments, full of oil-deposits, and with a spirality of nearly 400 per inch.

Wiesner's Biology of Plants.*—This work treats in detail of vegetable biology, arranged under the four following heads:—(1) Life of the individual; (2) Biology of reproduction; (3) Development of the vegetable kingdom; (4) Distribution of plants. Under the first head is given a review of plant-forms according to their mode of life, and a chapter on the origin and development of organs.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Meristem of Ferns.†—Prof. F. O. Bower has made an extended comparative examination of the meristem of a great variety of ferns, as a phylogenetic study. The following are the general conclusions arrived at, which tend to accentuate the contrast between the eusporangiate and the leptosporangiate series of Filicineæ.

As regards the roots, the apices of those of the leptosporangiate ferns are comparatively small, while those of the Osmundaceæ are larger, and those of the Marattiaceæ still larger. In the leptosporangiate ferns the apex of the root has always one tetrahedral initial cell; but in the Osmundaceæ there are often three or four initial cells. The initial cells of the Osmundaceæ and Marattiaceæ are narrower and deeper in proportion than in the leptosporangiate ferns, and are often not pointed, but rectangular at the base. In respect of the structure of the apex of the root, the leptosporangiate ferns, Osmundaceæ and Marattiaceæ, constitute an ascending series.

In the stem the apex of most leptosporangiate ferns is distinctly conical, while in Osmundaceæ and Marattiaceæ it is flatter and larger. In other respects the conclusions drawn from the comparative study of the apices of the stem in the three classes closely correspond to those drawn from the roots.

A comparative study of the apices of the leaves leads to the same general results. In the leptosporangiate ferns a two-sided apical cell with regular segments is the type for the leaf, though with a few irregularities; while in Osmundaceæ a three-sided apical cell with three rows of segments is the rule; and in *Angiopteris* (Marattiaceæ) the apex is occupied, not by one initial cell, but by a number, apparently three. The leptosporangiate ferns, Osmundaceæ and Marattiaceæ, therefore again form a series gradually increasing in complexity.

In the large majority of ferns the leaves are winged, and these wings may be traced, more or less distinctly, from the apex to the base of the leaf. In the Hymenophyllaceæ they are delicate and thin; in the

* 'Biologie der Pflanzen,' Wien, 1889. See Bot. Centralbl., xxxix. (1889) p. 286.
† Ann. of Bot., iii. (1889) pp. 305–92 (5 pls.).

Polypodiaceæ they are more robust; while in the Osmundaceæ, except *Todea*, and in the Marattiaceæ, they are thick and almost coriaceous, developing, in some genera, as the massive "stipules."

The sporanges, in their mode of origin and structure, give evidence of a similar series ascending in complexity and consisting of the Hymenophyllaceæ, Polypodiaceæ, Schizæaceæ, Osmundaceæ, and Marattiaceæ. The change in form of the archespore, from conical in the leptosporangiate ferns to cubical in the eusporangiate, is similar to that of the initial cells of the root, stem, leaf, and wing. The structure of the wall and the tapete is more complex in the eusporangiate ferns, and the number of spores in each sporange is larger, while the sporanges themselves are fewer in number.

Tissues of the Leaves of Ferns.*—Herr A. Vinge classifies ferns under three heads in relation to the structure of the tissue of their leaves, viz.:—(1) All the mesophyll-cells are flat, i. e. the vertical is less than the longitudinal or lateral diameter, even in the cells of the uppermost chlorophyllous layer; (2) the cells of the uppermost chlorophyllous layer of the mesophyll are usually nearly isodiametrical; (3) a typical palisade-parenchyme occurs on the upper side of the leaf. Several subdivisions are described in each class, and a large number of species named belonging to each subdivision.

Underground Development and Affinities of Sigillaria.†—M. Grand' Eury shows, by characters drawn from the development, together with those of reproduction, that the *Sigillariæ* are Cryptogams of a high degree of organization. The stem is characterized by presenting itself at first in the form of large undifferentiated tubers; and it is only gradually that the root assumes the character of *Stigmaria*. The author concludes by stating that the *Sigillariæ* belong to no living type of Cryptogams, and that they form a family of fossil plants which entirely disappeared at the end of the palæozoic epoch.

Leaves of Lepidodendron.‡—M. B. Renault describes the leaves attached to the branches of *Lepidodendron rhodunnense*, reserving for a later description those belonging to *L. esnostense*. The leaves of *L. rhodunnense* are small and short and 5–6 cm. long at the base, measuring 3 mm. and 1·5 in thickness. Their transverse section somewhat recalls the leaves of *Sigillaria*. The axis of the leaf is occupied by a single vascular bundle composed of radiating tracheids. The bundle is completely surrounded by a layer of parenchymatous cells, which constitute the liber; this liber is itself surrounded by a layer of thick sclerenchymatous cells. The leaves of *L. rhodunnense* differ from those of *Sigillaria* on the outside by the absence of the furrow on the upper surface of the leaf towards the base. When it exists in the middle region of the leaf it is less marked than in *Sigillaria*. The peculiar vasiform tissue which is common to these two genera of fossil plants was intended, no doubt, to ward off any inconvenient results caused by the alternating humidity and excessive dryness to which the plants of this epoch were exposed.

* Lunds Univ. Arsskr., xxv. (1889) 82 pp. and 3 pls. See Hedwigia, xxviii. (1889) p. 290.

† Comptes Rendus, cviii. (1889) pp. 879–83.

‡ Op. c., cix. (1889) pp. 41–3.

Muscineæ.

Peristome.*— M. Philibert continues to describe the differences between the Nematodonteæ and the Arthrodonteæ; and points out certain transitions between these two groups. The genus *Encalypta* can be divided into three principal sections, the peristome of which belongs to three different types:—(1) *E. procera* and *streptocarpa* show a well-characterized diplolepideous type. (2) *E. longicolla*, *brevicolla*, and *apophysata* represent the nematodonteous type, passing by degrees to the arthrodonteous. (3) *E. ciliata*, *rhabdocarpa*, *vulgaris*, and *commutata* form a third group, which includes most of the non-European species, where the peristome presents first the aplolepideous type, and then disappears completely.

The author concludes by describing the remarkable structure of the peristome to be found in the genus *Splachnum*, where we have an outer network, and beneath this a second network, and finally a third. This singular structure of *Splachnum* can easily be interpreted, and it will be found to belong to the general type of the diplolepideous peristome.

Sphagnaceæ and the Theory of Descent.†—Dr. Röll recurs to the consideration of the vast number of intermediate stages which bridge over the space between any two extreme forms in the genus *Sphagnum*, and proposes the construction of a genealogical tree which shall elucidate the relationships of the various forms to oneanother. He repeats his suggestion of the appointment of a "sphagnological" committee for the purpose of determining the limits of species or of forms, and questions of priority in nomenclature.

"Species" of Sphagnaceæ.‡—Herr E. Russow, from the examination of an enormous amount of detail of the bog-mosses, concludes that the variety of form is greater, and the limitation of species more difficult, than in the typical mosses or in other groups of plants. The author defines the term "species" in relation to Sphagnaceæ as a group of forms consisting of members united to one another in all directions, and sharply separated from another group of the same nature, it may be by only a single character.

Algæ.

Thallus of Delesseria.§—Mr. M. C. Potter describes the structure of the thallus of *Delesseria*, especially *D. sanguinea*. It is differentiated into a well-marked foliar expansion and a cylindrical portion—the "leaf" and the "stalk." The "leaf" is, with the exception of the "veins," only one cell in thickness; and the protoplasm is everywhere continuous from cell to cell through pits in the cell-walls. The "veins" are arranged like those of the leaf of a Dicotyledon, and are several cells in thickness, the cells being elongated instead of polygonal, like those of the rest of the leaf; their protoplasm is continuous,

* Rev. Bryol., xvi. (1889) pp. 67–77. Cf. this Journal, 1889, p. 673.
† Bot. Centralbl., xxxix. (1889) pp. 305–11, 337–44. Cf. this Journal, 1888, p. 775.
‡ SB. Dorpat. Naturf.-Gesell., 1888, pp. 413–26. See Bot. Centralbl., xxxix. (1889) p. 347.
§ Journ. Marine Biol. Ass., i. (1889) pp. 171–2 (2 pls.).

both among one another and with the adjacent cells; and this is also the case with the cells of the stalk. The thin "lamina" constitutes the assimilating tissue of the "leaf"; while the "veins" have a conducting function comparable to that of the veins in the leaves of flowering plants. The "stalk" serves also as a reservoir for food-material.

Development of the Fucaceæ.*—Dr. F. Oltmanns has followed out the development from the oosperm of a number of species belonging to the Fucaceæ. The species specially investigated and described in great detail are:—several species of *Fucus*, especially *F. vesiculosus*, *Pelvetia caniculata*, *Ascophyllum nodosum* and allied sp., *Halidrys siliquosa*, *H. osmundacea*, *Cystosira* sp., *Sargassum linifolium*, *S. varians*, *Himanthalia lorea*, and *Durvillæa Harveyi*. The thallus of all the species examined presents, at a definite period of their development, a club-shaped form with three-sided apical cell, agreeing in all essential points. Its further development may be classified under five heads, viz.:—(1) Durvilleæ; thallus a large stalked and variously divided and leaf-like structure bearing the conceptacles on the entire surface or on the margin, *Durvillæa*, *Ecklonia* (?), *Sarcophycus* (?); (2) Loriformes; young plant radiar, afterwards assuming a bilateral form; shoot branching dichotomously, with a three-sided apical cell; conceptacles wanting only on the lower, much smaller part of the plant; oogone with only one oosphere, *Himanthalia*; (3) Fuceæ; young plant radiar, very soon passing into bilateral or dorsiventral; shoots with four-sided apical cell; branching dichotomous or monopodial; conceptacles only on the slightly modified apices of the primary or lateral shoots; oogones with 2–8 oospheres; *Fucus*, *Pelvetia*, *Ascophyllum;* (4) Cystosireæ; the plant either maintains its radiar structure, or forms bilateral branches; three-sided apical cell permanent; branching monopodial; conceptacles on slightly modified apices of branches, or on special branches; oogone with one oosphere; *Halidrys*, *Pycnophycus*, *Cystosira*, &c.; (5) Sargasseæ, bilateral or radiar structure with three-sided apical cell; the branches form at the base one or more leaf-like branches, which give the plant a peculiar habit; conceptacles on special branches; oogone with one oosphere; *Sargassum*, *Turbinaria*, *Carpophyllum*, &c.

With regard to the number of oosperms in an oogone, the author found the number of original nuclei to be always eight; and those which do not develope into oospheres are still to be clearly detected at the period of maturity. His observations on the actual mode of impregnation closely correspond to those of Thuret.

Conferva and Microspora.†—After a *résumé* of the observations hitherto made on the various species of Confervaceæ by different algologists, Prof. G. v. Lagerheim gives a careful diagnosis of these two genera and of all their known species. In *Microspora* the chloroplasts have the form of branched bands containing starch; in *Conferva* of small discs which do not contain starch; in other words, the products of

* Haenlein u. Luerssen's Biblioth. Bot., Heft 14, 1889, 100 pp. and 15 pls.; and SB. K. Preuss. Akad. Wiss., xxx. (1889) pp. 585–99 (1 pl.).
† Flora, lxxii. (1889) pp. 179–210 (2 pls.). Cf. this Journal, 1888, p. 94.

assimilation consist in the former genus of starch, in the latter genus of some other substance, possibly the drops of mucilage. In *Microspora* there are two kinds of spores; the megaspores have two or four cilia, and escape by the breaking of the wall of the mother-cell or by its gelatinization, and pass over, on germination, into a resting condition, either in the form of aplanospores or akinetes; in *Conferva* megazoospores only are known, which are uniciliated, escape only by the rupture of the cell-wall, and germinate directly into new filaments. The genera agree in having only a single nucleus in each cell, and in the structure of the cell-wall.

Under *Microspora*, Lagerheim enumerates thirteen species, including two new ones, *M. Willeana* and *M. Moebii;* and in it are comprised also several species usually placed under *Conferva* or *Ulothrix*, as *C. stagnorum*, *U. tenerrima*, and *U. seriata.* Under *Conferva*, in which the resting-cells (not formed from zoospores) always have the form of aplanospores, two species only are named, *C. bombycina* and *C. utriculosa.* The author regards both these genera as fully formed organisms, and not as stages of development of higher algæ.

The other genera of the order are *Hormiscia*, *Urospora*, *Chætomorpha*, *Ulothrix*, *Schizogonium*, *Hormidium*, *Rhizoclonium*, *Glœotila*, *Binuclearia*, and *Uronema*. *Tribonema* is a synonym of *Conferva bombycina.*

Cephaleuros.*—This genus, found growing on leaves in Surinam' and placed by its discoverer, Kunze, among the Mucoroideæ, and later among Lichens, is now referred by M. P. Hariot to the Trentepohliaceæ among Algæ; and he thinks it probable that it is the algal constituent of the lichen-genus *Strigula*, at least of some of its species, while those of other species of *Strigula* belong to the genera *Phycopeltis* and *Protococcus*, while other species referred to *Strigula* are not lichens at all.

With regard to *Hansgirgia flabelligera* and *Phyllactidium tropicum*, the author agrees with De Toni,† that these are distinct species, although the genera *Hansgirgia* De Toni, *Mycoidea* Hans., and *Phyllactidium* Moeb. should be sunk in *Phycopeltis;* and the original *Mycoidea* of Cunn. is superseded by *Cephaleuros.*

Botrydiopsis.‡—Under the name *Botrydiopsis arhiza* Prof. A. Borzì describes a new species and genus of green algæ belonging to the Botrydiaceæ. It occurs in the form of a dense green layer on a wall over which water is constantly trickling. In its ordinary condition it consists of perfectly spherical cells, in some cases as much as 30–40 μ in diameter. It possesses a distinct but very thin membrane clothed with a number of chromatophores. In young individuals the protoplasm is homogeneous, with a nucleus distinguishable only with difficulty; no starch or oily substances could be detected. Each individual, when it has attained its full size, becomes a zoosporange, the zoospores being formed, with great rapidity, by successive bipartitions of its contents. The zoospores are quite naked, without any pigment-spot or pulsating vacuole, but with a remarkably active power of movement by means of

* Journ. de Bot. (Morot), iii. (1889) pp. 274–6, 284–8 (6 figs.).
† Cf. this Journal, 1889, p. 786. ‡ Boll. Soc. Ital. Micr., i. (1889) pp. 60–70.

a long and extremely slender cilium. As soon as the motion ceases the zoospore rounds itself off, and begins to germinate.

Botrydiopsis may also multiply vegetatively by repeated divisions; and the resulting cells may either become transformed directly into zoosporanges, or may go through a period of rest in the form of hypnosporanges invested by a thick membrane, the contents of which subsequently divide into zoogametes; these are biciliated, without a pigment-spot or pyrenoids, and conjugate in groups of 2, 3, 4, or rarely a larger number. The zygosperms thus formed are perfectly spherical, with a diameter of 10–15 μ. After a period of rest, they develope into individuals precisely resembling those from which the series started.

Signor Borzì considers *Botrydiopsis* as most nearly allied to *Botrydium*, but as approaching the typical Confervaceæ through *Bumilleria* (*Hormotheca*). He proposes to divide the Confervales into 3 families, viz.:—(1) Sciadeaceæ (*Characiopsis* n. gen., *Characii* sp. auct., *Peroniella*, *Chlorotheceium*, *Mischococcus*, and *Sciadium*, including *Ophiocytium*); (2) Confervaceæ (*Conferva*, *Dictyothele*); (3) Botrydiaceæ (*Bumilleria*, *Botrydiopsis*, and *Botrydium*).

Boodlea.*—Mr. G. Murray describes this new genus of Siphonocladaceæ, with the following diagnosis:—Alga viridis, marina, spongiosa, aspectu frondis defecta, ex filis confervoideis regulariter articulatis, iterum atque iterum ramosis, quocumque vergentibus, inter se per tenacula adhærentibus composita. The only species, *B. coacta*, is from Japan.

The author regards the genus as forming a very important link in establishing a connection between the Siphoneæ and the jointed green algæ. The individual filaments closely resemble those of *Cladophora*; but instead of forming one plane, as in *Microdictyon*, they run in all directions, and are united by apical tenacles into a body which, when swollen with water, has a pulpy spongy texture, and is net-like in whatever section it may be viewed. The apical tenacles adhere to any portion of the adjoining filaments with which they may come in contact.

Dr. G. B. de Toni † refers to this genus several species hitherto included under *Microdictyon*.

Volvox.‡—Mr. E. Overton has made a careful study of the structure and development of this genus, especially of *V. minor*. His results agree to a large extent with those of Klein.§ He is disposed to regard the organism as an individual rather than as a colony. The colouring-matter of the red pigment-spot he finds to present similar chemical and optical properties to that of the fruit of *Solanum*. He confirms recent observations that the globe is filled, not with water, but with a mucilaginous substance. The parthenospores are found only in the posterior hemisphere. In *V. globator* the number of these is almost invariably eight, while in *V. minor* it varies between one and eleven. The number of antherozoid-plates varies in direct proportion to that of the parthenospores or ovum-cells.

* Journ. Linn. Soc. (Bot.), xxv. (1889) pp. 243–5 (1 pl.).
† Malpighia, iii. (1889) pp. 14–7.
‡ Bot. Centralbl., xxxix. (1889) pp. 65–72, 113–8, 145–50, 177–82, 209–14, 241–6, 273–9 (4 pls.).
§ Cf. this Journal, 1889, p. 558.

The paper concludes with a full diagnosis of the two European species, *V. globator* and *V. minor* Stein (*V. aureus* Ehrb.), and a discussion of the systematic position of the Volvocineæ. Stein's *V. Carteri* from Bombay seems to be intermediate between the two European species. The nearest relationship of the Volvocineæ appears to be undoubtedly with the Chlamydomonadineæ, that with the Chrysomonadineæ, *Synura* and its allies, being not nearly so close, the chromatophores differing both in form and colour. The author places *Volvox* in the Flagellata of Bütschli, which he regards as belonging to the Algæ rather than to the Protozoa. The presence of pulsating vacuoles cannot be laid down as a criterium for Protozoa, and the presence of a nucleus has been determined by Schmitz. Bütschli's subdivision of the Flagellata into four groups, the Monadina, Euglenoidina, Heteromastigoda, and Isomastigoda, may be accepted in general terms. The test relied on for an organism belonging to the vegetable kingdom is the presence of true chromatophores, although the absence of chromatophores cannot be regarded as determining its animal nature. Since chromatophores are always the result of division, and not of new formation, their presence must necessarily be of great morphological importance.

Antherozoids of Eudorina.*—M. P. A. Dangeard has observed a case in which the results of the division of a cell in *Eudorina elegans* were not grouped in a disc-like fashion, but formed a hollow sphere, resembling a young vegetative colony; the cells afterwards become longer than broad. From this he concludes that the differentiation of the male and female cells in *Eudorina* and *Volvox* had its origin in the conjugation of isogamous planogametes.

Fungi.

Respiration of Fungi.†—Prof. G. Arcangeli has determined the elevation of temperature which takes place during the development of the receptacle of fungi, which he finds to be invariable in the species examined, *Armillaria mellea*, *Phallus impudicus*, *Lepiota excoriata*, *Clavaria flaccida*, *Polyporus fraxineus*, *Clitocybe spinulosa*, and *Scleroderma Geaster*. The period of maximum elevation was found to be always about the middle of the day, varying between noon and 2.30 P.M., and the greatest elevation recorded was 1°·25 C. in the case of *Lepiota excoriata*.

Salmon-Disease.‡—Mr. A. P. Swan gives a detailed account of the life-history of *Saprolegnia ferax*, and of the conditions under which salmon are liable to its attacks.

New Entomophthoraceæ.§—The following additional new species of Entomophthoraceæ are described by M. Giard:—*Entomophthora Cyrtoneuræ*, on the abdomen of the dipter *Cyrtoneura hortorum*; *E. telaria*, on the cantharid *Ragonycha melaneura*; *E. arrenoctoma*, on Tipulidæ; *E. Syrphi*, on Syrphidæ; *E. Isatophagus*; the last two

* Bull. Soc. Linn. Normandie, ii. (1889) pp. 124–7. See Bot. Centralbl., xl. (1889) p. 138.

† Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 405–12.

‡ Rep. and Proc. Belfast Nat. Hist. Soc., 1888–9, pp. 54–85 (1 pl.).

§ Bull. Scient. de la France et de la Belgique, 1888, p. 296. See Bot. Centralbl., xl. (1889) p. 211. Cf. this Journal, 1889, p. 561.

possibly only varieties of *E. Muscæ;* and *Lophorhiza Carpentieri.* All the gnats attacked by the parasite were males.

New Chytridiaceæ.*—M. P. A. Dangeard describes two new species of *Chytridium*, *C. Brebissonii*, parasitic on *Coleochæte scutata*, in which the sporanges have 4–8 strap-shaped appendages on the anterior side; and *C. simplex*, parasitic on the cysts of *Cryptomonas*, the sporanges being outside the gelatinous envelope of the host, and the rhizoids penetrating into it.

New Fungus-parasite of the Cucumber.†—Under the name *Ustilago Cucumis* Dr. A. B. Griffiths describes a fungus which attacks the roots of the cucumber, causing the well-known nodular swellings on the root rich in albuminoids. It differs from the normal Ustilagineæ in the absence of septa in the hyphæ. The spores retain their vitality for a long time in the soil. The fungus was readily cultivated in Sachs' nutrient solution.

Fasciation of Mucedineæ.‡—By this term M. J. Costantin understands the *Coremium*-form of such fungi as *Penicillium*, and proposes that when both forms of any species are known, the name by which it was first described should be retained, but with the prefix "syn" or "haplo," accordingly as it is the coremial or the simple form; thus *Coremium* must in future be known as *Synpenicillium ;* but that when a generic name has been employed for compound fungi belonging to different forms, it should be suppressed; thus *Isaria* must be replaced by *Synsterigmatomyces.* He further states that *Coremium vulgare* is a fasciate form of *Penicillium crustaceum*, and *Isaria farinosa* of a form resembling *Spicaria ;* and that there are similar relationships between *Stysanus stemonitis* and *Hormodendron*, and between *Verticillium ruberrimum* and *Acrostalagmus cinnabarinus : Isaria arachnophila* is the coremial form of a *Sterigmatocystis.*

Alternaria and Cladosporium.§—M. J. Costantin describes both *Alternaria* and *Cladosporium*, and the various forms which they assume when cultivated. *Alternaria tenuis* is a filamentous fungus with a short fertile stem. *Cladosporium*, which is a very common fungus, has never been well described, on account of the variability of its microscopic characters. The author then traces the passage of *Cladosporium* to *Hormodendron*, and gives a short account of several species belonging to both these genera. In conclusion, he states that it is possible to obtain by the culture of *Alternaria* forms closely resembling *Cladosporium*, observation confirming this result while multiplying the stages of passage to a form which can reproduce itself as *Cladosporium.* This last form can transform itself into *Hormodendron.*

Fusisporium moschatum.‖—Dr. J. Heller found on a dried-up anatomical specimen a fungus-growth which he decided was identical with the *Fusisporium moschatum* described by Kitasato ¶ and others.

* Bull. Soc. Linn. Normandie, ii. (1889) pp. 152–3. See Bot. Centralbl., xl. (1889) p. 138.
† Proc. Roy. Soc. Edinb., xv. (1887–8) pp. 403–10 (1 pl.).
‡ Soc. Mycol. de France, iv. (1888) pp. 62–8 (1 pl. and 7 figs.) See Bot. Centralbl., xl. (1889) p. 212.
§ Rev. Gén. de Bot., i. (1889) pp. 453–66, 501–7 (2 pls.). Cf. this Journal, 1889, p. 563.
‖ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 97–105 (3 figs.).
¶ Cf. this Journal, 1889, p. 560.

The spores of *F. moschatum* are crescentiform or sickle-shaped. Their average length is 20 μ, and their breadth 1–3 μ. Each spore usually shows three, or even four, transverse septa. When grown on potato, the spores are seen to contain many vacuoles or areas of attenuated protoplasm which are faintly stained by dyes. Besides the vacuoles there are also highly refracting corpuscles, possibly droplets of fat. Although a spore-membrane is not demonstrable, the constancy of the form of the spores is striking evidence of its existence. The spores are easily stained with an aqueous solution of any anilin dye, but unlike the spores of Bacteria and those of *Penicillium glaucum*, which only stain with anilin water plus pigment, retaining the stain after decolouring action of hydrochloric acid, *Fusisporium* loses its stain after this treatment.

The author observed the germination of the spores in hanging drops of gelatin.

The macroscopical appearance of a colony varied with the nutritive medium, and development was possible only within certain limits of temperature, the most favourable being about 15° C. *Fusisporium* is not only essentially aerobic, but water is indispensable for its development.

It forms a red pigment diffused in both the mycelium and the spores, but is most intense in the latter. It is developed more copiously in potato-cultivations than in bouillon. The author found that it was insoluble in alcohol and ether, but, according to De Bary, this fungus produces two pigments—one soluble in water, and the other insoluble in water and soluble in alcohol and ether.

Fusisporium exhales an odour which resembles, according to both the author and Kitasato, that of musk. It is perceptible in cultivations on any medium, but is stronger from some than from others, notably potato.

Inoculation experiments made with cold-blooded animals (frog) showed that it would develope as an epiphyte on the skin, but doing no material harm, while when injected beneath the skin the animal died in the course of a few weeks, and *Fusisporium* was found post-mortem in the viscera.

Botrytis cinerea.*—Herr S. Kissling has undertaken an exhaustive investigation of the variations in this parasitic form of *Peziza Fuckeliana* when growing on various host-plants. The following is a summary of the more important results:—

The germ-filaments from the conids penetrate very readily the delicate parts of the flower, and especially the anthers and stigmas. The mycele which grows rapidly on these parts is infective. It spreads in the flower-stalk and axis, and hence attacks organs where direct infection from the conids is impossible. Plants containing much water, and with a thin epiderm, also offer very little resistance to its attacks. The injury inflicted by the hyphæ is due to the excretion of an enzyma. The conids of later generations germinate much more rapidly than those of earlier ones. This parasite causes extensive injury to *Gentiana lutea* growing wild, to greenhouse plants, and to chestnuts stored up in cellars. The vegetative and the propagative hyphæ of *Botrytis* differ

* Hedwigia, xxviii. (1889) pp. 227–56.

greatly from oneanother; the sclerote has no other function than that of propagation, and is incapable of infection. Starting from the sclerote, the myceles of later generations are more infective than the earlier ones. Culture on different substrata alters the form of the conidiophores, and the activity of the conids; and the unequal rapidity of growth is dependent on variations in the nature of the food-supply.

Peziza tuberosa.*—Dr. J. H. Wakker describes the structure and development of this fungus, parasitic on several species of *Anemone*, especially *A. nemoralis* and *ranunculoides*, in which it causes the disease known as "morve noire"; and the nature of the injury which it inflicts on the tissues. The well-known "gumming" of hyacinths and other bulbs the author is unable, on the other hand, to trace to the attacks of any parasite.

Trichomes within Trichomes.†—Dr. G. Ritter Beck v. Mannagetta records this peculiar structure in the brown segmented marginal filaments of *Peziza hirta*—trichome-like mycelial filaments penetrating the cell-cavity of neighbouring trichomes. He compares the phenomenon with the well-known prolification of the rhizoids of *Marchantia* and *Lunularia*.

Platysticta.‡—Under this name Dr. M. C. Cooke establishes a new genus of Stictieæ, formed from *Platygrapha magnifica* B. & Br., and *Lichenopsis sphæroboloides* Berk. The genus *Lichenopsis* must be suppressed; and the following is the diagnosis of the new genus:—Erumpens, orbicularis, urceolatus, marginatus; disco plus minus decedente; sporidiis magnis, hyalinis, pluriseptatis vel muriformibus, dissilientibus.

Taphrina deformans.§—Signor U. Martelli describes the injury inflicted on the leaves of the peach-tree in Italy by this fungus. The hyphæ do not penetrate through the stomates, and the asci appear to be formed on the upper surface only of the leaf.

Organisms of Leaven and their relation to the fermentation of bread.‖—Herr W. L. Peters, who has recently examined the micro-organisms found in bread-yeast, states that, as a rule, three *Blastomycetes* were present, and on one occasion a fourth variety, in the yeasts he examined. In addition to these he also describes three kinds of bacteria and two kinds of bacilli.

The bacteria and *Saccharomyces* were easily distinguished from starch-granules by means of anilin-water-methyl-violet, which stained the microbes and left the starch-granules uncoloured. This preliminary investigation is of some importance, inasmuch as a previous observer had denied the existence of *Saccharomyces* in yeast.

Pure cultivations of the three varieties were easily obtained. The first variety the author identifies with *Saccharomyces minor* Engel. This form is almost always quite spherical, with a diameter of 3·5 μ. The second

* Arch. Néerland. Sci. Exact. et Nat., xxiii. (1889) pp. 373–400 (2 pls.).
† Oesterr. Bot. Zeitschr., xxxix. (1889) pp. 205–6.
‡ Grevillea, xvii. (1889) pp. 94–6.
§ Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 532–5.
‖ Bot. Ztg., xlvii. (1889) pp. 405–19, 421–31, 437–49. Cf. this Journal, 1889, p. 253.

variety is nearly equal in size to the former, but is oval in shape, and measures 3–4 μ in length and 2·5–3 μ in breadth. This form has no name. The third variety is *Mycoderma vini*, which occurs in very variable quantities. In fresh yeast the quantity is small, but as the leaven becomes stale the quantity increases, and the author is disposed to regard it as an impurity. The fourth variety, only occasionally found, is apparently *Saccharomyces cerevisiæ*. No importance is attached to its presence.

Bacterium A. This is a small rod about $1\frac{1}{2}$ times longer than broad. It was isolated in neutral gelatin, and does not possess any positive characteristics.

Bacterium B, isolated in a similar way, is about 1·5 μ long and 0·4 μ broad. It was found to possess a slight power of dissolving starch, and of forming lactic acid in the presence of a yeast-water-sugar solution.

Bacterium C is about 1·6 μ long and 0·8 μ broad; the individual elements are rounded at one end and pointed at the other. It is incapable of movement. This bacterium was found to produce acetic fermentation, and the cultivation fluid used for the purpose was neutral yeast-water, to which 5 per cent. of alcohol had been added.

Bacillus D was isolated on gelatin plates, and found to consist of individuals 2–3 μ long and 0·5 μ broad. These elements are mobile in one stage of their development; they produce spores and also long motionless filaments at other periods of their existence. It does not liquefy gelatin, but was found to dissolve starch.

Bacillus E. The spores of this bacillus are about 1·6 μ long and 0·8 μ broad. Grown in hanging drops, these swell up, forming small rods with rounded ends. After a short time these begin to increase by fission and become active. The rods then grow out into long threads. The cultivation medium was boiled white of egg, the ordinary sugar-pepton-meat-extract-gelatin being found useless, although, if the sugar were replaced by soluble starch, the gelatin was rapidly dissolved. It was also found that this bacillus was able to liquefy starch. In this experiment wheat-starch was mixed with sterilized yeast-water.

From his experiments with the foregoing organisms, the author concludes that the fermentation of bread called forth by yeast consists in a series of coincident and co-operative processes, of which the most essential, the alcoholic fermentation, is effected by Saccharomycetes, while the lactic fermentation and the dissolvent processes are matters of only secondary consideration.

Cotton-blight.*—Mr. L. St. Pammel has determined the cause of the widely-distributed "root-rot" of the cotton-plant or cotton-blight to be the attacks on the root of a parasitic fungus *Ozonium auricomum*, the same that causes also the rotting of the batatas, vine, mulberry, apple, and *Dolichos*.

Uredo-stage of Gymnosporangium.†—Mr. H. M. Richards states that since, in their mode of germination, both the obtuse and fusiform

* Bull. Texas Agricult.-Exp. Station, Dec. 1888, pp. 3–18. See Bot. Centralbl., xl. (1889) p. 59.

† Bot. Gazette, xiv. (1889) pp. 211–5 (1 pl.). Cf. this Journal, 1889, p. 563.

spores bear the promyceles characteristic of teleutospores, we must conclude that, if the obtuse spores are teleutospores, the fusiform spores are also teleutospores. The only ground for supposing that the latter are uredospores is the statement of Kienitz-Gerloff that they do not produce promyceles, but rather the tubes found in uredosporic germination. *G. clavariæforme* is the only species in which two forms of teleutospores are known. The mode of germination of the teleutospores of *Gymnosporangia* is subject to a good many modifications, depending, in part at least, on the variations in the amount of moisture to which they are subjected.

Æcidium of Melampsora Euphorbiæ.*—Herr P. Dietel finds the hitherto unknown æcidio-form of this Uredine on the same host as the uredo- and teleutospore-forms, viz. *Euphorbia dulcis;* this form making its appearance in the spring, and the other two generations in the autumn, on the same individual.

New Poisonous and Luminous Fungus.†—Under the name *Agaricus* (*Pleurotus*) *noctilucens*, Dr. Y. Inoko describes a fungus parasitic on the Japanese beech, *Fagus Sieboldi.* A strong white luminosity is exhibited by the gills; this is less intense on the surface of the pileus, and altogether absent from the stipe. It is evidently the result of a process of rapid oxidation. The alcoholic extract was poisonous to dogs, rabbits, mice, and frogs.

Development of the Hymenogastreæ.‡—Dr. R. Hesse describes a new species of *Leucogaster* under the name *L. floccosus*, differing from *L. liosporus* in the very thin and flocculent peridium, which is destitute of pores, in the very irregular form of the spores, and in its onion-like odour. Connected with the failure of all attempts hitherto made to germinate artificially the spores of the Hymenogastreæ, Tuberaceæ, and Elaphomycetes, he states his belief that in the first of these families, as in the two latter ones,§ the phenomenon, hitherto described as the decay or dissolution of the fructification, has a totally different significance, and must be regarded as the commencement of the period of reproduction; the structures, hitherto believed to be bacteria, which appear in great abundance during this process, playing an important part in this reproduction.

Spore-formation in Phlyctospora.‖—The mode of formation of the spores in this rare underground genus of Fungi has not hitherto been observed. It was placed by its discoverer Corda among the Sclerodermaceæ, by Rabenhorst among the Trichogastreæ. Dr. G. Beck has now determined that the spores are borne on swollen club-shaped basids, each basid producing from two to five spores on very short sterigmas. The basids present the peculiarity of producing a large number of filamentous outgrowths, which envelope the ripe spores in a weft. *Phlyctospora* must be placed in the Hymenogastreæ among the Melanogastreæ.

* Oesterr. Bot. Zeitschr., xxxix. (1889) pp. 256–9. Cf. this Journal, 1889, p. 266. † Mitteil. Med. Facult. K. Japan. Univ., i. (1889) pp. 277–306 (1 pl.).
‡ Bot. Centralbl., xl. (1889) pp. 1–4, 33–6 (2 pls.).
§ Cf. this Journal, 1889, p. 679.
‖ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 212–6 (5 figs.).

Structure of Phallus impudicus.*—M. C. v. Bambeke describes in great detail the morphology of *Phallus* (*Ityphallus*) *impudicus*, especially of the peridium. He states that it consists of five layers, the mode of formation of which is fully described, as is the nature of the hyphæ of which they are composed. In the outermost layer occur imperfect loop-connections, and intercalary cavities which contain sphærocrystals of calcium oxalate. In all the layers are hyphæ with swollen ends, containing a homogeneous mucilaginous substance, which the author regards as analogous to the latex-tubes of *Lactarius*, *Russula*, &c.

Ward's Diseases of Plants.†—After a general account of parasitic and saprophytic Fungi, and the mode in which they act in the "damping off" of seedlings, and in the production of "fingers and toes," "anbury," and "club root," Prof. Marshall Ward gives a succinct description of the life-history and pathogenic action of the fungi which produce the potato-disease, the smut of corn, "bladder plums" or "pocket plums," the lily-disease, the ergot of rye and other grasses, the hop-disease, and the rust of wheat.

Protophyta.

α. Schizophyceæ.

Structure of Diatoms.‡—In his contribution to the algal flora of Siberia, M. W. Koslowskij describes a new species of *Pinnularia*, *P. oblongo-linearis*, which presents the peculiarity of the cells always having two nuclei lying on each side of the shorter plane of symmetry, each imbedded in a mass of denser protoplasm bounded by a strongly refringent protoplasmic membrane.

The author contests Wallich and Pfitzer's views of the double character of the valve of diatoms. It is a peculiar and temporary phenomenon belonging only to certain forms, and occurs only when the individual is in the act of dividing, never in young individuals; while many species do not exhibit it at any time. He further states that in the act of division entire young valves are never formed, but only the sides, without new girdle-bands, which coalesce directly with the old band. It is therefore not necessary that successive generations should decrease in size. The double character of the shell results, when it does occur, from the girdle-band splitting into three layers, the middle one of which is converted into mucilage.

The author further explains the wavy appearance of the front-view of *Cymatopleura Solea*. The valve-side has a row of transverse furrows and ridges, which, in different individuals, are either confluent or symmetrical.

Raphidodiscus.§—Mr. C. M. Vorce describes this rare and anomalous genus of diatoms from Virginia, and proposes the following diagnosis:—Valves discoid, with a central thickening or obscure nodule, and an interrupted raphe terminated by minute spines or spiniform nodules

* Bull. Soc. Roy. Bot. Belgique, xxviii. (1889) pp. 7–50 (3 pls.).
† 'Diseases of Plants,' by H. M. Ward, London, 1889, 12mo, 196 pp. (53 figs.).
‡ Arb. Kiew. Naturf. Gesell., ix. (1888) pp. 395–436 (1 pl.) (Russian). See Bot. Centralbl., xl. (1889) p. 40.
§ Microscope (Detroit), ix. (1889) pp. 132–7 (1 pl.).

somewhat within the margin of the disc; central portion of disc naviculoid, depressed, its ends terminating in the spines; striæ radiate, moniliform, extending from the raphe to the margin of the valve. The author considers that the three described species should be reduced to one, *R. Christianii*, and that the nearest affinities of the genus are with *Aulacodiscus* and *Eupodiscus*, differing from them only in the presence of a raphe. He considers that it should be placed among the Cryptoraphidæ in H. L. Smith's classification, as an abnormal genus possessing a raphe or pseudo-raphe. *Melonavicula* appears, however, to enjoy priority as the generic name.

β. Schizomycetes.

Formation of Nuclei and Spores in Bacteria.*—Dr. P. Ernst has, by means of three quite different methods, demonstrated in a number of bacteria a new element, small granules which are most frequently seen when the bacteria are developing with difficulty or are about to sporulate. There is no constancy in the number of these granules, for there may be one or more. They stain blue-black in warm alkaline methylen-blue and cold Bismarck-brown solution. Delafield's hæmatoxylin stains them black-violet, and Platner's nucleus-black blackish.

The author believes that he has proved that these granules develope into spores, and therefore calls them *sporogenous granules*.

As they did not under some conditions become stained with Neisser's spore-stain, they are to be considered as being actually different from spores, although the predecessors of these. This view is further supported by the fact that hæmatoxylin and Platner's nucleus-black stain the granules, but not spores. In their earlier condition they are easily peptonized (3 hours in solution of pepsin 0·5, HCl 0·2, H_2O 100), but as they become older the greater is their resistance to digestion; and this is complete when they have developed into spores. With methylen-blue-Bismarck-brown the sporogenous granules stain blue-black, the spores blue. All boiling fluids, including pure water, cause their disappearance. The granules are certainly not vacuoles, and do not consist of fat (insoluble in boiling ether), or of starch (do not stain with iodine).

Relations of Purple Bacteria to Light.†—The forms studied by Prof. T. W. Engelmann are well known, viz. *Bacterium photometricum, roseo-persicinum, rubescens, sulfuratum; Beggiatoa roseo-persicina; Clathrocystis roseo-persicina; Monas Okeni, vinosa, Warmingi; Ophidomonas sanguinea; Rhabdomonas rosea; Spirillum rubrum, violaceum.* All these are coloured more or less intensely by a red-purple matter diffused throughout the protoplasm, Bacteriopurpurin; and their reaction to light is due entirely to this substance, and not to the presence or absence of sulphur or sulphuretted hydrogen.

The influence of light on purple bacteria is shown very markedly by the production of various movements, according to the various species; and the amount of these movements appears to vary directly as the

* Zeitschr. f. Hygiène, v. (1888) 61 pp. (2 pls.); cf. Bot. Centralbl., xxxviii. (1889) p. 853.

† Arch. Néerland. Sci. Exact. et Nat., xxiii. (1889) pp. 151–98. Cf. this Journal, 1888, p. 473.

intensity of the light. And not only do differences and variations in the intensity of the light affect these bacteria, but they are sensitive to differences of wave-length; this sensitiveness depending on the species, the individuality, and external conditions. In addition to visible rays, they are affected by certain ultra-red radiations; so that mobile forms will gather together in the ultra-red between λ 0·90 and 0·80. They also collect in other bands, but in decreasing quantity between λ 0·61–0·58, λ 0·55–0·52, λ 0·75–0·64, and in the ultra-violet. From this disposition a "bacteriospectrogram" is formed by the bacteria themselves beneath the cover-glass.

Spectroscopic examination of the colour, and calculations as to the absorption of the dark heat-rays by these bacteria, were carefully made by the author, who sums up the results in tables, for which the original must be consulted.

That the purple bacteria give off oxygen under the influence of light was demonstrated from the zoogl\u0153a conditions of *D. photometricum*, *Monas vinosa*, *Warmingi*, *Okeni*, and *Clathrocystis roseo-persicina*. As tests it was necessary to employ Schizomycetes very sensitive to oxygen. In the result it was found that these purple Schizomycetes occupy a place among those organisms which assimilate after the manner of green plants, and that bacterio-purpurin may be considered a true chromophyll; inasmuch as, after having absorbed the actual energy of the light, it transforms it into potential chemical energy. In conclusion, the relations between the assimilation and absorption of rays of different wave-lengths by bacterio-purpurin are entered into. Put shortly, this may be summed up as the more light the more oxygen, and the most striking proof of this was furnished by the experiments with the ultra-red rays. Here all visible rays were occluded by means of a 4 cm. layer of bisulphide of carbon. These experiments also show that the disengagement of oxygen is not connected with the action of the visible rays, but that the dark rays are equally capable of setting free oxygen.

New Capsule Bacillus.*—Dr. Pfeiffer found in the abdomen of a guinea-pig a puriform exudation, which was found not to consist of pus, but to be a pure cultivation of bacilli, which were also found in considerable quantity in the blood.

These bacilli have rounded ends, and are arranged in longer or shorter filaments. They are enveloped in a capsule, wherefore the author proposes to call them *Bacillus capsulatus*. They are not endowed with motion. They grow luxuriantly on gelatin, agar, bouillon, and potato. They do not liquefy gelatin. They are pathogenic for both white and house mice, these animals dying in two or three days. After death the bacillus is discoverable in all the organs and juices of the body. Guinea-pigs and pigeons could be infected from the peritoneal cavity, but rabbits through the circulation only. This bacillus is said to be easily distinguishable from the pneumonia bacillus and the pseudo-pneumonia bacillus.

Bacterium phosphorescens.†—Prof. K. B. Lehmann, who, in conjunction with Dr. P. Tollhausen, has been making some experiments

* Zeitschr. f. Hygiène, vi. (1889) p. 145.
† Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 785–91.

with *Bacterium phosphorescens*, finds that on salt-gelatin stained red with phloxin, the bacteria grew up of a red colour, and on methylen-blue-gelatin a dark blue. The coloration was intimately associated with the presence of oxygen, for along the needle track the bacteria were colourless.

The appearance of the organisms under the Microscope was very variable. In young colonies the most frequent form was short rods with rounded ends. These were usually in pairs. As the colony grew older, the rodlets tended to become ovalish or spheroidal, and were mixed up with all kinds of involution-forms. No spores were observed, and specific movements were quite absent.

If the gelatin were only slightly acidulated (acetic acid), the fungus grew brilliantly, but increased acidulation diminished development, and finally stopped it. Similar observations were made with alkalies.

The illuminating power of these bacteria seems to depend entirely on the presence of oxygen. On saline media a green-coloured light is developed; while, if the salinity be scanty, the light is less and more yellowish. The light is developed only on the surface of the culture, the organisms in the deeper parts being non-illuminant. Hydrogen, carbonic acid, and carbonic oxide rapidly extinguish the light. If a liquid medium be shaken up, the whole fluid becomes phosphorescent.

The fungus was found not only to be able to live well but to grow without developing light.

The phosphorescence originates in one of two ways :—(1) The process is intracellular ; that is, the molecular processes within the cells, which in general give rise to heat, the formation of carbonic acid, &c., are here followed by the development of light; or (2) the bacteria produce by their metabolism a substance which unites with oxygen outside the cells, and thereby light is produced. The formation of such a photogenic substance would place it on a level with the chromogenous substances produced by some bacteria, e. g. by *Bacillus prodigiosus*.

The fact that the light is wanting after filtrations through porcelain, and disappears on the addition of disinfectants, would seem to favour the extracellular theory. But experiments at different temperatures decided the author in favour of the intracellular view. It was found that the greatest light was given off at 24° C., and that it was extinguished at 39·5°. On cooling the culture down to 0·1°, a faint light was observed for four days, and even at − 12° the light remained for 10–12 minutes.

Certain gases, such as CO, CO_2, and H, were found to extinguish by merely preventing the access of oxygen; while H_2S acted toxically, the illumination rapidly disappearing and not returning on the cultivation being shaken up with air, while after-inoculations showed that it was sterilized. Sulphate of morphia produced no effect, nor did saponin. Strychnine had a slow and slight influence on the phosphorescence ; while sulphate of quinine had a decided result.

Photobacterium luminosum.*—M. W. Beyerinck describes a new phosphorescent bacterium which he obtained from the sea water near Scheveningen.

The edge of puddles left by the retreating tide on a warm summer's

* Arch. Néerland. Sci. Exact. et Nat., xxiii. (1889) pp. 401–5 (4 figs.).

day is found to be passing rich in bacteria. Some of such water is sown on the following media:—A decoction of fish is made in sea water, and to this 0·5 per cent. peptone and 7 per cent. gelatin are added. Some of the luminous puddle-sand is then mixed up with boiled sea water and a few lines traced across the gelatin with a needle dipped in the mixture. The gelatin is then covered with sea water, and the latter drained off. At the end of about twenty-four hours, at summer heat, numerous brightly luminous colonies will have appeared. *P. luminosum* liquefies gelatin if this be effected in the presence of a large quantity of nitrogenous matter. No fœtid products are evolved, but when the amount of azotized material is insufficient, a putrefactive process takes place. Like other phosphorescent bacteria, *P. luminosum* developes only in neutral or slightly alkaline media, a small quantity of acid being sufficient to prevent the production of light. On gelatin or peptonized meat-broth the bacterium will not develope unless 3–3·5 per cent. of sea salt, of chloride of potassium, or chloride of magnesium be added.

In form this bacterium varies with the cultivation medium. When this contains little nitrogen or a small quantity of carbohydrates, the bacterium is small, and resembles the cholera vibrio. Among the rods, spirilla, more or less long, may be seen, and these sometimes break up into short vibrios. Both spirilla and vibrios move rapidly towards the margins of the preparation, where they gain access to free oxygen, without which their development is impossible.

Like other phosphorescent bacteria, descendant colonies of *P. luminosum* frequently diminish in luminosity, and even cease to emit light. The exact conditions which give rise to this degeneration are not at present understood, but certain differences in the nutrient media have direct influence on the light-production. This diminution in the luminosity is always accompanied by a similar diminution in the liquefying power, and also by changes in the shape of the organism. Among the substances which cause this diminution are glucose, levulose, maltose, and asparagin.

Luminosity of Bacteria and its relation to Oxygen.*—In examining the relations between the luminosity of bacteria and free oxygen, M. W. Beyerinck employed three species of photobacteria—*P. phosphorescens*, *indicum*, and *luminosum.* In addition to the physiological combustion from the influence of free oxygen to which the phosphorescence is owing, the reducing and fermenting functions had also to be taken into consideration. In estimating the amount of action excited by oxygen, the author made use of hydrosulphate of soda and indigo. His conclusions on the subject of luminous bacteria in general, and *P. phosphorescens* in particular, are that oxygen necessary for anaerobiosis, called fixed or exciting oxygen, is not of itself able to maintain phosphorescence, but it can keep up, at least to a certain degree, both the fermentative and reducing functions of the organism.

As regards phosphorescence, the oxygen must be in a more free condition; and though this oxygen is not physically dissolved in the

* Arch. Néerland. Sci. Exact. et Nat., xxiii. (1889) pp. 416–27.

living substance of the bacteria, it forms with the protoplasm a combination capable of maintaining itself in vacuo.

Action of Bacillus pyocyaneus on Anthrax.*—Owing to the experiments of Bouchard, who found that inoculation with *Bacillus pyocyaneus* had some effect on the development of anthrax, MM. Charrin and L. Guignard have endeavoured to ascertain the mechanism of this influence by examining *in vitro* the action of the microbe of blue pus upon that of charbon. With this intent the pus bacillus was sown in active charbon cultivations. Guinea-pigs were inoculated with the mixed cultivations. During the first six days the virulence of the anthrax was not modified in any constant manner, but from the eighth day the virulence was diminished; thus, while a pure anthrax cultivation killed in three or four days, the mixed culture required seven or eight days. From the twentieth day, although the results were not constant, the guinea-pigs became immune. It is noteworthy that if the attenuated virus be sown in pure bouillon, the germs regain their virulence. The diminished virulence is accompanied by morphological modifications; involution-forms make their appearance, and spores are not developed.

The authors conclude that in the attenuation of the charbon microbe by that of blue pus, the products of the latter play some part, and this first by secreting some substance harmful to the development of charbon, and secondly by using up the nutritive medium.

Anthrax, Tuberculosis, and Actinomycosis.†—Prof. E. M. Crookshank publishes seven reports relating to anthrax, tuberculosis, and actinomycosis, containing numerous facts hitherto misunderstood or overlooked. The two papers on anthrax relate to the disease in swine and horses. It had been hitherto presumed that while swine died after eating carcases of animals dead of anthrax, they were not really susceptible to the disease. Now Prof. Crookshank succeeded in infecting swine with true anthrax; consequently the liability of swine to suffer from this disease is set at rest, while the same observations also go to prove that the anthrax organism does not grow readily in the pig.

The report on tuberculosis was instituted chiefly with regard to the infectivity of milk, and also to tubercular mammitis. It was found that the milk of cows suffering from tubercular mammitis contained tubercle bacilli; and, taking into consideration that the milk of cows is, in dairies, mixed together before distribution, it is laid down that there is danger in using such milk. The report concludes with a case of transmission of the disease from man to cows, and general remarks on the tubercle bacillus. In these remarks it is shown that while the disease is common to many animals, the pathological expression of the disease is different in different species and individuals, and also that there are morphological differences in the bacilli.

The third disease, actinomycosis, is discussed at considerable length, but at the same time with perspicuity, and these four papers form together the best *résumé* of the subject in the English language we have seen. This fungus disease, which has been found to attack almost every

* Comptes Rendus, cviii. (1889) pp. 764–6.

† 'Annual Report for 1888 of the Agricultural Department Privy Council Office, on the Contagious Diseases, &c., of Animals (Appendix),' 1889, pp. 20–128 (23 pls.).

part of the body, was first brought into notice by Bollinger in 1876. The first cases were discovered in oxen, but a few years afterwards the same disease was found in man. The macroscopical appearances vary with the anatomical distribution, and also with the rapidity of the disease. The microscopical appearances of the fungus are of two kinds, club-shaped elements which tend to arrange themselves in rosettes, and delicate filaments. The club-shaped elements, which were the first to be recognized, easily stain a red colour, while the filaments, which were only discovered comparatively recently, stain blue. It is owing to this staining difference that Prof. Crookshank was able to demonstrate the intimate connection between the two; for, by making careful preparations, he has shown that the filaments spring out of the clubs, and that "the structure of a rosette consists centrally of a dense mycelial network, and externally of a hymenium of basidia."

The question of transmissibility from man to lower animals is easily answered in the positive, for calves and rabbits have been successfully inoculated with the fungus.

By the aid of the Microscope, the author was able to show that "wens" or "clyers" are only local manifestations of the disease; previously they were regarded as the result of a strumous or tubercular diathesis.

These seven reports are copiously illustrated from photographs and microscopical preparations, in all twenty-three plates.

Micro-organisms of the healthy Stomach and their action.*—M. J. E. Abelous confirms the results of Pasteur and Duclaux relative to the action of microbes in the stomach, and the part they play in digestion. The microbes were taken from the author's stomach by washing it out after fasting. The usual precautions were taken to prevent external contamination, and the mouth and pharynx were previously washed out with sublimate. The microbes were cultivated on gelatin, peptonized and glycerined gelatin, potato, gelatinized serum, neutral and acidulated bouillon. The species isolated were *Sarcina ventriculi*, *Bacillus pyocyaneus*, *Bacterium lactis aerogenes*, *Bacillus subtilis*, *Bacillus mycoides*, *Bacillus amylobacter*, *Vibrio rugula*, and nine other species, which are distinguished by letters, A, B, C, &c. These include one coccus and eight bacilli. The chief facts about these are that their resistance to an artificial gastric juice is greatly in excess of the mean duration of digestion in the stomach, and that they are potentially anaerobic.

The author also examined the separate and collective action of the microbes in certain sterilized alimentary substances. These were skim-milk, egg-albumen, fibrin, gluten, lactose, cane-sugar, glucose, and starch. From these experiments he concludes that these microbes act more or less energetically on alimentary substances, but that the real theatre of their action is rather the intestine than the stomach.

Micro-organisms of Malaria.†—Dr. M. B. James concludes from his researches that (1) there occur in the blood of malaria patients appearances which are included under the name *Hæmatozoon malariæ*; (2) the half-moon-shaped bodies appear only in chronic cases; (3) the segment

* Comptes Rendus, cviii. (1889) pp. 310-2.
† Medical Record, xxxiii. (1888) p. 269.

form is visible only immediately before or during the cold stage; (4) all forms, except the half-moon shape, disappear after large doses of quinine; (5) malaria can be induced by the intravenous injection of malarial blood.

The foregoing statements are regarded as matters of fact, and the following, though hypothetical, quite probable:—That (1) between the appearances in the blood and the disease there exists an ætiological connection; (2) these appearances are not present in the blood under other circumstances; (3) the bodies described are to be considered as one and the same organism; and (4) no form except the flagellate is to be regarded as an independent organism.

New Pleomorphous Schizomycete, Bacillus allantoides.*—Dr. L. Klein describes a pleomorphous bacillus which he obtained originally $4\frac{1}{2}$ years ago from an impure cultivation of *B. megatherium.* The name given to the species is derived from the sausage-like zooglœa. Starting from a rod-stage in the developmental cycle, the micro-organism is distinguished as motionless rodlets about $0 \cdot 5\ \mu$ thick and three or four times as long. The motionless rods grow up into filaments of 4–8 cells, surrounded by a gelatinous membrane. Slight but distinct movements are now visible, and in this mobile condition the individual elements are capable of immediate reproduction, forming short filaments. These secondary bacilli next degenerate into coccus-like elements, then rapidly multiply, and pass on to the sausage-like zooglœa-stage. The next step in the development shows the bacilli being reproduced from the zooglœa mass.

Movements of Micrococci.†—Professor Mendoza, after alluding to Dr. Ali-Cohen's communication on the specific movements of Micrococci,‡ states that he was the first to describe a micrococcus endowed with motion. This micrococcus was found by the author when examining for *Sarcina ventriculi.* Cultivations on various media showed that the fungus was essentially a tetrad, forming on gelatin plates white circular sharp-edged colonies. With increasing age the colonies became sugar-coloured, and gave off an odour resembling skatol. The fungus did not liquefy gelatin. In fluid media development was slow, and the cultivation dark to the bottom.

Morphologically this coccus is almost always a tetrad, although this form is sometimes less obvious. It possesses a distinct capsule and sheath inclosing a finely granular protoplasm.

The movements are best seen in fluid media, and consist in rapid forward rollings of the tetrads, which seem to turn in various directions. The name given by the author to this microbe is *Micrococcus tetragonus mobilis ventriculi.*

Recent Bacteriology.—Dr. H. C. Ernst reports§ on recent advances in Bacteriology. As he cites a number of medical journals, such as the 'Präger Medicinische Wochenschrift,' 'Le Bulletin Médical,' and Russian medical journals, he gives information as to a number of discoveries which there has been no opportunity to note in this Journal.

* Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 383–6 (16 figs.).

† T. c., pp. 566–7.

‡ Cf. this Journal, 1889, p. 795.

§ 'Annual of the Universal Medical Sciences.' Issue for 1889. Philadelphia, 1889, vol. v. section 1, 24 pp.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Mirand's and Klönne and Müller's Microscopes with revolving stages.—In 1880 we described † the Microscope of MM. Klönne and Müller with a revolving stage for eight slides, which had then been issued. Subsequently we heard of a similar instrument by M. Mirand in which, however, the stage had also a motion from back to front, so that three objects could be observed on each of the slides, and in 1883 we described ‡ this as an extension of the principle of MM. Klönne and Müller's Microscope. It is now stated § that M. Mirand's instrument was exhibited at the Paris Exhibition of 1878, and was therefore the original form, so that in place of the French makers having devised a "modification mieux comprise," it is the German makers who are responsible for an "imitation mal comprise."

Nobert's Micrometer-Microscopes.—Fig. 1 shows an early form of Microscope devised specially by the late F. A. Nobert for fine measurements by stage-micrometer.

The chief peculiarities in the design are (1) the application of the stage-micrometer, and (2) the arrangement of the fine-adjustment.

(1) The stage-micrometer is a permanent attachment of the stage, the micrometer-screw acting upon a travelling stud fixed beneath the upper plate, causing it to traverse the field of view laterally. The screw is actuated by a large radial wheel, the spokes being of such a length that a very small movement can be effected. The radial wheel is removable, when the Microscope can be used for ordinary observations.

(2) The fine-adjustment is effected by a screw passing through the standard from the back and pressing against a bar or arm about 2 inches in length, extending downwards at the back of the stage. The stage is suspended on the standard on coned screw-pivots fitted in a fork-piece, and is easily detached by releasing the pivots by the milled heads shown on either side of the standard. The fine-adjustment screw pressing against the bar beneath the stage causes the latter to incline upwards from the horizontal, and so to approach the objective; with the reverse motion of the screw the stage inclines the opposite way by gravitation. This system of fine-adjustment was (we believe) first devised by Herr Nobert, and has been largely adopted in Germany for low-priced Microscopes.

Fig. 2 shows the improved form of Micrometer-Microscope as exhibited by Herr Nobert at the Exhibition of 1862.‖

(1) The stage-micrometer with its graduated drum and vernier is carried by the stage, whilst the screw is actuated by a large milled

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† This Journal, 1880, p. 144.

‡ This Journal, 1883, p. 897.

§ Journ. de Micrographie, xiii. (1889) pp. 523–4.

‖ Vide Reports of the Juries, Class XIII., p. 25.

head (instead of the radial wheel of fig. 1), which is supported on a separate standard and connected with the screw by a Hooke's joint. We believe this plan of providing a separate standard for the milled

Fig. 1.

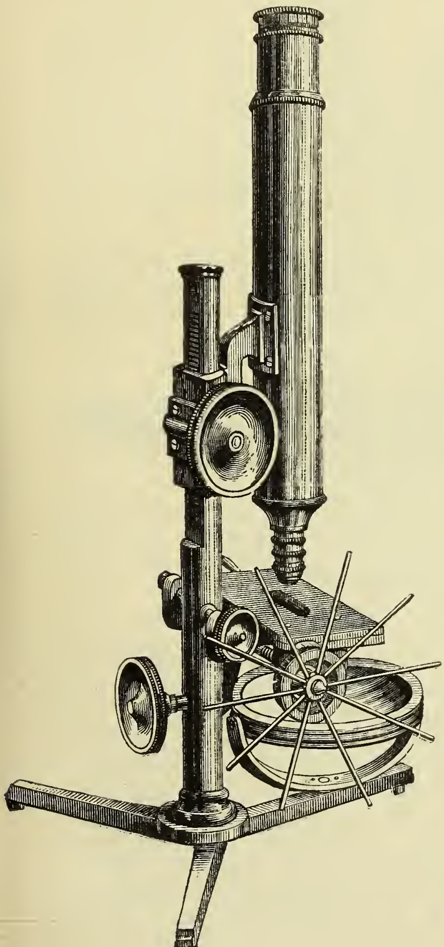
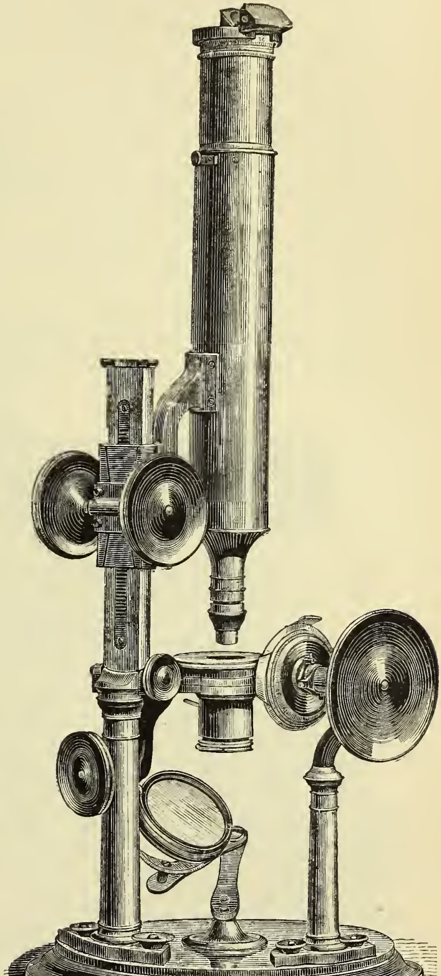


Fig. 2.



head and actuating the screw by means of a Hooke's joint was devised by Herr Nobert to avoid the tremor of the hand being communicated to the micrometer, and yet to utilize this peculiar fine-adjustment acting upon the stage.

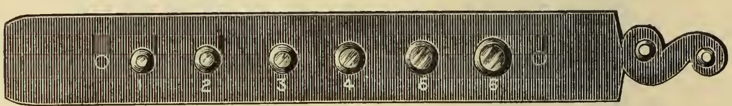
(2) The base is double; the upper plate, carrying the standards of the Microscope and of the micrometer, rotates on the lower on a centre in the line of the optic axis.

(3) The mirror is attached to a rotating cylinder in the centre of the lower base-plate by two elbow joints set at an angle, by which it can be adjusted at any angle in altitude beneath the object, whilst maintaining very nearly an equal distance from the object in all positions. The mirror can thus be rotated radially upon the object, or *vice versâ*.

The example of this second form of Nobert's Micrometer-Microscope in Mr. Crisp's collection is furnished with a mechanical stage (with glass surface) in which the rectangular movements are effected by means of a single plate. Fine micrometer-screws are applied to project from two right-angle edges of the stage and pass through fixed shoulder-rings; each screw has a spiral spring encircling it and pressing against the shoulder-ring; milled nuts exterior to the shoulder-rings act on the micrometer-screws, giving very smooth and delicate rectangular movements to the stage.

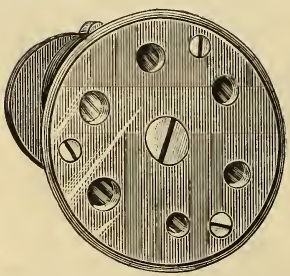
Old Microscope with nose-piece for rapidly changing objectives and mirror formed of a silvered bi-convex lens.—The nose-pieces of which so many were brought out a few years ago for rapidly changing

Fig. 3.



the objectives were generally considered to represent an entirely modern idea, though our forefathers had placed objectives in a long dove-tailed slide like fig. 3, or more commonly in a rotating disc like fig. 4.

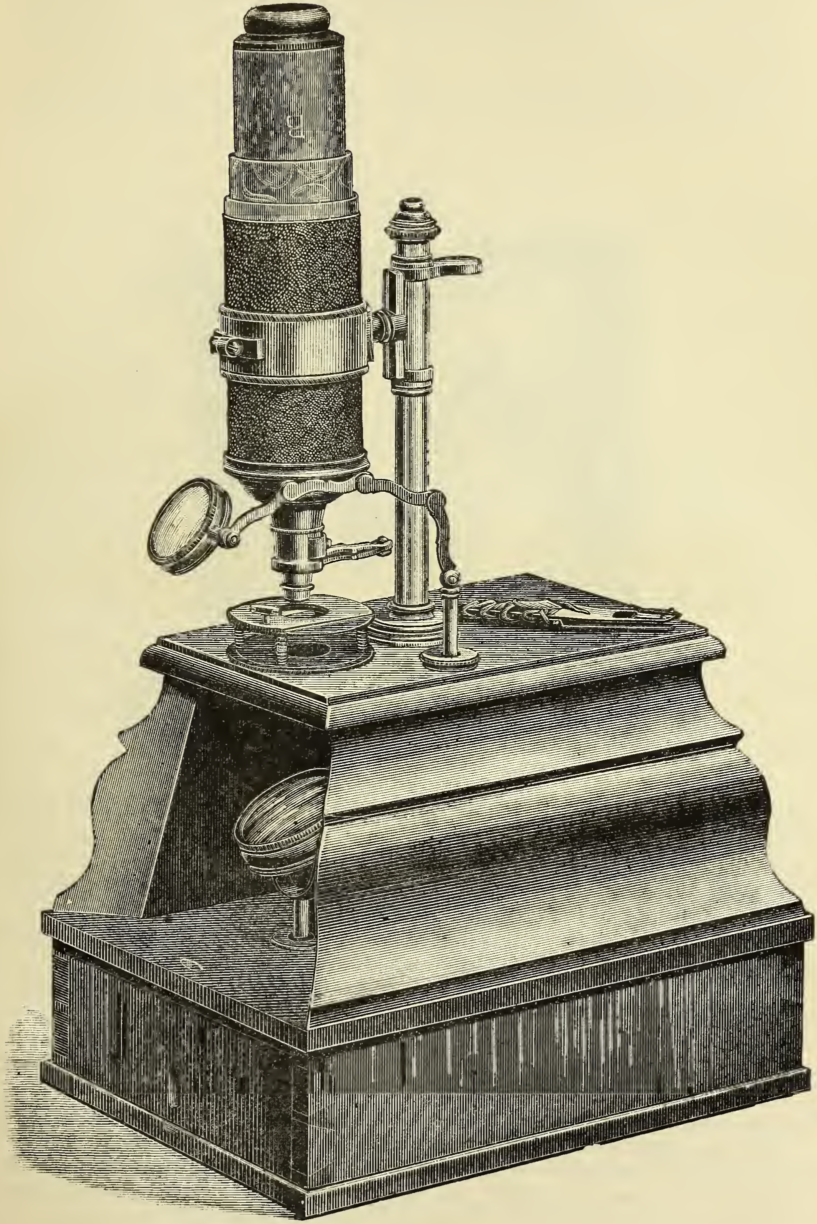
Fig. 4.



An old Microscope recently acquired by Mr. Crisp (shown in fig. 5) has an arrangement which is doubtless the earliest of its kind. To the body-tube is screwed a nose-piece, to which is attached a short arm, on which pivots a second arm with a "cell" at the end, into which the objectives drop. To change the objective the second arm, which has a slight amount of "spring," is depressed and then swung away from the body-tube, the objective lifted out of the cell and another inserted in its place, and the arm turned back again. The cell, which is about 1/8 in. deep, fits over the end of the nose-piece, and thus keeps the objective in position.

The Microscope is apparently of Augsburg make, probably by G. F. Brander, whose career as a mechanician and optician was comprised between the years 1734 and 1783, when he lived at Augsburg. The mirror is a biconvex lens silvered—a device which has been reinvented more than once during the last ten years!

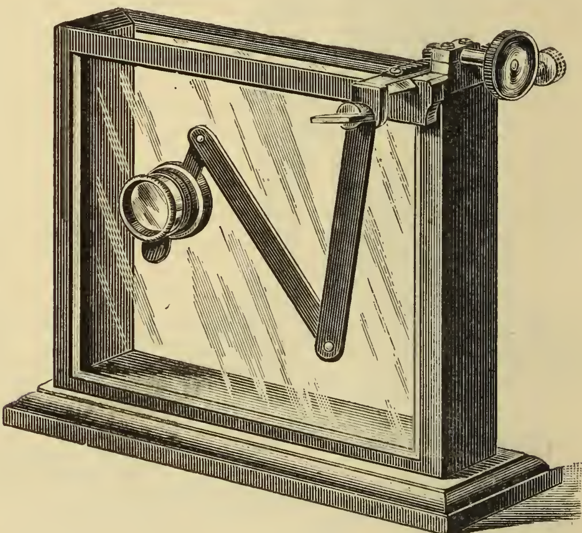
FIG. 5.



Rousselet's Simple Tank Microscope.—Mr. C. Rousselet exhibited at a recent meeting of the Society a small tank Microscope (fig. 6) designed for the purpose of rapidly looking over pond water and weeds collected at a day's excursion and placed in a small parallel-sided window aquarium.

One of Zeiss' aplanatic lenses is carried on a jointed arm, which moves parallel to the side of the tank, and the lens is focused by means

Fig. 6.



of a rack and pinion, the whole being fixed to the upper left-hand corner of the tank by means of a screw clamp.

The following points, Mr. Rousselet considers, will recommend themselves to those who are in the habit of looking at their captures with the pocket-lens in the ordinary way:—

When an object of interest is found it can be followed with the greatest ease and taken up with a pipette, both hands being free for this operation. It frequently happens that a minute object is lost simply by removing the pocket-lens for an instant to take up the pipette; in the above apparatus the lens remains in the position in which it has been placed. The definition of these aplanatic lenses is excellent; the lowest power has enough working distance to focus through tanks of moderate size, and the magnification (6 diameters) is sufficient to permit of the identification of all ordinary rotifers, and anything uncommon or new is at once recognized. Such delicate creatures as the Floscules, which are all but invisible with the ordinary pocket-lens, are seen without difficulty, and the whole contents of the tank can be ascertained with a great saving of time.

Mr. Rousselet also specially recommends these small window aquaria to those not already acquainted with them, as affording the very best means of examining pond water for microscopic life.*

In Mr. Rousselet's original figure the lens-carrier was clamped on the vertical side of the tank; we have ventured to show the apparatus clamped on the top of the tank, where we think it will be found safer in practice.

(2) Eye-pieces and Objectives.

New Objective of 1·63 N.A.—This objective is further described by Dr. H. Van Heurck † (see also the paper by Dr. S. Czapski, *supra*, p. 11), who says that "its advantages have surpassed all that could be hoped for."

The design of the objective was started by Prof. Abbe four years ago, but it was only in August last that he was able to complete the preliminary calculations and to commence the actual execution of the objective, which was finished on the 17th September.

The objective is 1/10 in., apochromatic, and with an aperture of 1·63 N.A. A special compensating eye-piece 12 removes the last traces of colour. The cover-glasses of Dr. Van Heurck's objects have a refractive index of 1·72, and the slide is approximately of the same index; both are of flint glass. The diatoms are melted in the cover-glass. The mounting medium has an index of 2·4, and the immersion fluid (monobromide of naphthaline) an index of 1·65. The aperture of the immersion condenser is 1·60 N.A., and the upper lens is of flint, for utilizing the most oblique light. Monobromide of naphthaline is used here also as the immersion fluid.

The lenses of the objective are thus disposed:—

(1) Front lens (more than a hemisphere) of flint. Index 1·72.
(2) Achromatic lens.
(3) Crown-glass lens.
(4) Achromatic lens.
(5) Correcting lens (three glasses).

Three of the lenses are in fluorite.

Prof. Abbe considers that the difference between the indices of the cover and the immersion liquid notably favours the resolution.

In regard to its management, Dr. Van Heurck has used it daily for two months, and for hours together, and he finds it in every way as practical as other objectives of large aperture.

"In oblique light *Amphipleura* is entirely resolved in beads, as clearly as we see *Pleurosigma* with the best existing objectives, the beads being much closer than the previous imperfect resolutions had led one to believe. Repeated measurements of photographs show that it has 3600 transverse and 5000 longitudinal striæ per millimetre. It is not, therefore, surprising that there has hitherto been so much difficulty in showing these beads.

It is only for these beads that oblique light is required. All the other difficult tests, such as *Frustulia saxonica*, *Surirella gemma*, and

* Journ. Quek. Micr. Club, iv. (1890) pp. 53–4 (1 fig.).

† Cf. Bull. Soc. Belg. Micr., xv. (1889) pp. 69–71; Journ. de Microgr., xiii. (1889) pp. 527–8.

even the transverse striæ of *Amphipleura*, are resolved with axial light. *Pleurosigma angulatum* shows new details which have still to be studied. On examining it without the eye-piece eleven spectra are seen, i. e. five new intermediate spectra. Some bacteria have also shown new details.

The illuminating power of the objective is very great. Strong photographs of the beads of *Amphipleura* have been obtained in six minutes with a magnification of 1500 diameters with monochromatic solar light, whilst with the ordinary apochromatics at least ten minutes was necessary with only 1000 diameters and ultra-oblique illumination.

Only three objectives have yet been made, two for the Continental tube and one for the English. One of the former is in the hands of Dr. Koch, the Berlin bacteriologist, and will, it is hoped, give some interesting results.

Dr. Van Heurck considers that "the new objective forms an honourable practical crowning of the long theoretical labours of the illustrious Prof. Abbe, who for fifteen years has so happily led the Microscope into new paths, and who has with indefatigable patience realized practically all that theory indicated."

Semi-apochromatic Objectives.—Mr. E. M. Nelson read the following note at the December meeting:—

As these new semi-apochromatics are "Students'" lenses, let me briefly trace their development. The earliest form of student's lens was a combination of three "French buttons" or doublets; almost the whole of the medical and students' work, both here and on the Continent, was carried on by means of these lenses. The one I am exhibiting to-night is an example of the favourite form in this country, the sale of which, as I am credibly informed, must be counted by thousands. This lens gave way to the Hartnack, which consisted of two doubles and a single. The Hartnack was an immense advance over the French button, but looking at them from a present day point of view, we should say that while some picked specimens were good, the bulk of them were very mediocre. Somewhat later came Seibert of Wetzlar. His lenses, in form not differing greatly from those of Hartnack, were decidedly superior to them in finish; at the same time, his angles were low for the most part. Of his lenses two even now justly have world-wide celebrity. I allude to his No. III. and his water-immersion 1/16.

Before leaving Seibert let me point out that a Seibert No. III., unscrewed from its brass mount, constitutes the best high-power pocket-lens ever made. One mounted like a Coddington would be a useful appendage to a microscopist's outfit, as it has fully 1/8 in. working distance, which the Coddington has not.

One other point. You are all aware that on the Continent almost nothing has been done with low-power lenses. Seibert alone of all the Continental makers produces a No. 0, which is a first-class $1\frac{1}{2}$ in. With this lens Mr. Rousselet and myself have seen the cilia on *Volvox*. An example of this lens is on the table. The Hartnack was superseded by the Zeiss achromatic, a lens much of the same form, i. e. two doubles and a single, but altogether of superior workmanship. Zeiss also, by making each class of lens both wide and low angled, suited all tastes. To illustrate this period of lens I have brought a D D or 1/6 in.

I have now come to the time when English opticians made students'

lenses; they adhered to the usual form of two doubles with a single front. Among the first and most successful was Swift; an early example is on the table. This lens is a 1/5, and was sold for half the price of the English 1/4 of that day.

A new competitor appears on the field, viz. Reichert of Vienna. The example before you is one of the first batch of his lenses that came to this country; it is a 1/7 of 0·84 N.A., very well corrected and very well finished. Its price was 2*l.*, and at that time there was nothing made here that would at all compare with this lens for three times that sum. Next in order comes Leitz of Berlin, who was mainly known by his 5*l.* oil-immersion, and now as I have brought up the history to recent times I will give no more particulars with regard to achromatics, but go straight to semi-apochromatics.

I call these lenses "semi-apochromatics" because, while they are not "apochromatic," they possess a higher degree of achromatism, due to the employment of Jena glass in their construction, than previously possible with the old glass. Among others the most remarkable instance of the capabilities of this Jena glass will be seen in the production by Leitz of two lenses, a 2/3 of N.A. 0·26 and a 1/8 of 0·88 N.A. The 2/3 is a remarkably fine lens which has no achromatic rival, even though it consists of only two pairs, and the 1/8, which to my fancy is rather too high in power for its aperture, by far surpasses any similar achromatic lens. Now when we remember that the price of these two lenses together is only the modest sum of 2*l.* 8*s.*, we are in a position to realize the great strides the manufacture of Microscope lenses has made quite recently. I hope to show a blow-fly's tongue under one of these presently.

In this country Swift has made use of Jena glass in the production of "Students'" lenses with great success; some dry 1/6 and 1/8 may be specially noted as having eclipsed every similar lens, and this without entailing any extra complication in construction.

Last week Mr. Baker sent me a new Reichert 5*l.* oil-immersion 1/15 of 1·25 N.A., which on measurement I found to be a true 1/12 of 1·24 N.A. Under this lens I am exhibiting the secondaries of *Coscinodiscus Asteromphalus.*

This lens is the finest oil-immersion I have ever seen, excepting only the apochromatics. The spherical aberration is beautifully balanced, as can be seen by the large cone of illumination used, viz. the full aperture of the Zeiss achromatic condenser, with bull's-eye. Beyond this, however, the lens falls off. I know of no similar lens that will stand such a severe test. The object I have chosen has thick intercostal silex, and therefore is especially one to show up any colour left outstanding. The thicker the silex the stronger the colour (hence an excellent means of determining roughly the thickness of diatomic structures). Most lenses show this same object deeply coloured. With another object such as a *Navicula Rhomboides* (Cherryfield) in balsam, the silex on either side of the raphe will appear as very pale lilac. The lens also shows admirably a difficult test such as the secondaries on *Aulacodiscus Sturtii.* Such a lens cannot fail to play an important part in the microscopy of medical and science schools.

At present it is a short-tube lens, but by slightly closing the lenses it could be made into an objective for the long tube.

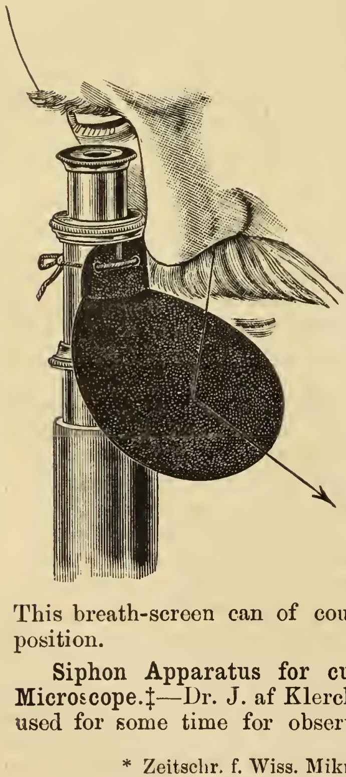
In conclusion let me ask you to go back to the microscopy of 1879, and then you will be better able to appreciate the great advance that has taken place in the improvement of the optical portion of the Microscope during the past ten years.

(3) Illuminating and other Apparatus.

Improvement in Abbe's Camera Lucida.*—Dr. H. W. Heinsius has devised the following alteration in Abbe's camera, so that it can be readily removed from the eye-piece and replaced, and that without disturbing the coincidence of the two images. The special advantage of the arrangement is that it allows the details of the preparation to be directly inspected from time to time, an advantage which any one who has tried to draw with a camera of any sort will appreciate.

A ring of blackened brass of the same dimensions as the lower part of the camera, is connected by means of a joint to the arm which carries the mirror, and at the place where this is screwed to the mount of the prism. The three binding screws pass through the new tube instead of the old one, and thus clamp the instrument to the Microscope. One slight alteration is necessary in order to prevent the neutral-tint glasses from falling out when the camera is turned up. The frames of these glasses are turned so that the latter are pushed in at the front and not at the top.

Fig. 7.



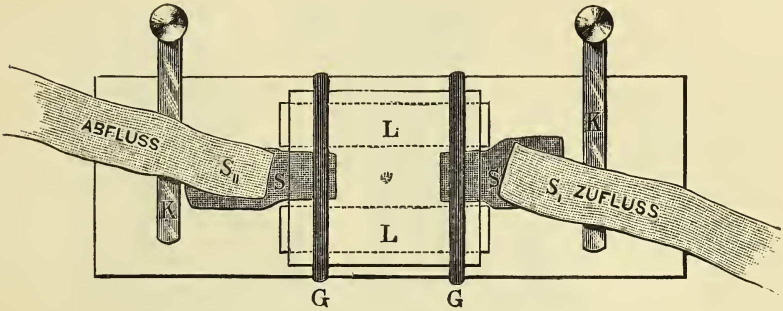
Breath-screen.†—In snub-nosed persons, says Dr. P. Schiemenz, the expired air tends to pass down parallel to the tube during a microscopical examination. The deposit of moisture, especially in winter, is sometimes annoying, and to obviate this the author recommends the adoption of a screen. This (fig. 7) may be made of a piece of stiff paper, the principal part of which is nearly circular (diameter about 8 cm.). The smaller portion is pierced by two holes, through which passes a string by which the apparatus is attached to the Microscope-tube. This breath-screen can of course be easily fixed in or moved to any position.

Siphon Apparatus for cultivating living organisms under the Microscope.‡—Dr. J. af Klercker describes an apparatus which he has used for some time for observing living organisms under the Micro-

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 36–7.
† T. c., pp. 37–8 (1 fig.).
‡ T. c., pp. 145–9 (3 figs.).

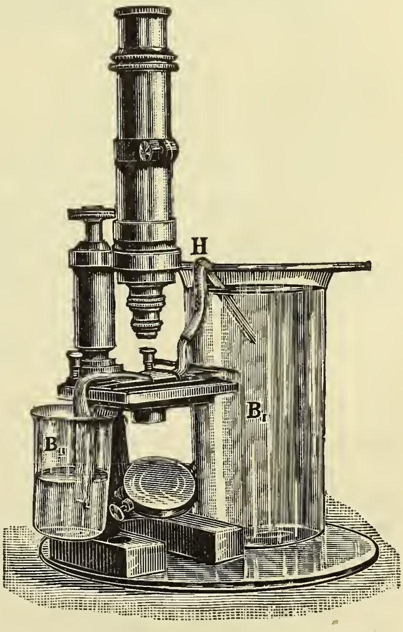
scope (figs. 8–10). The current of water for keeping the organisms alive is maintained by siphon action. Two oblong strips L of cover-glass (0·14 mm.), 28 mm. long and 6 mm. broad, are fixed parallel to

Fig. 8.



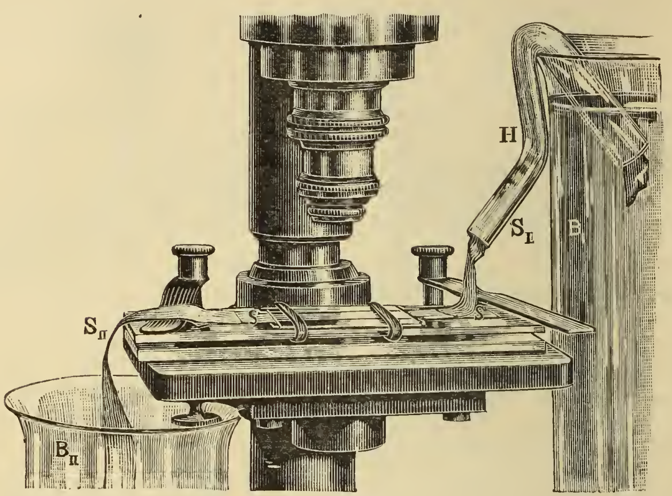
each other on a 3 by 1 in. slide, and at a distance of 8 mm., by means of Canada balsam. Within the channel thus formed is placed the object to be examined in a largish drop of water, and then a fairly large cover-glass superimposed. Should the object not be exactly in the centre, it can easily be pushed into the desired position by inserting a bristle or glass thread under the cover-glass. At each end of the channel a short piece of linen S is pushed under the cover, which is fastened to the slide by a couple of rubber rings G. A second slide is laid underneath the first, and the two connected by means of wax. The pair of slides are then fixed to the stage in the usual manner by the clamps K. A large glass vessel $B_{,}$, the lip of which projects over the Microscope for about 5 cm., is filled with water, and in this hangs a doubly bent siphon H. Within the siphon is placed a strip of linen S_1, the free end of which lies on the short strip S. By this arrangement a constant and regular inflow of water is assured. The volume of water passing through the siphon is easily regulated by jamming the linen strip S_1 into the siphon tube more or less tightly. The outflow is managed by means of another strip of linen $S_{,,}$, one end of which rests upon the short

Fig. 9.



strip S, while the other dips down into a tumbler B_{II} placed below and underneath the Microscope stage. With this apparatus nearly 50 ccm.

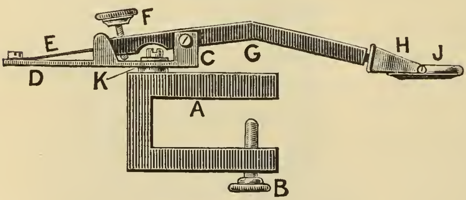
Fig. 10.



of water flows across the stage in the twenty-four hours, this being at the rate of about 3 cm. a minute.

Schulze's Compressorium.*—The object of this apparatus (fig. 11) is to apply pressure to an ordinary slide when upon the stage.

Fig. 11.



A B is a clamp to be attached to the side of the stage, carrying the piece C D, which rotates on the pin at K. The bent lever G is supported at C, and can be raised and lowered against the spring E by the screw F. At the other end of G is the fork H, in which screws a ring J, with an opening of 12 mm.

The apparatus is screwed on the stage so that the opening of the ring lies on the cover-glass of the preparation, when by turning the screw F pressure can be applied as desired.

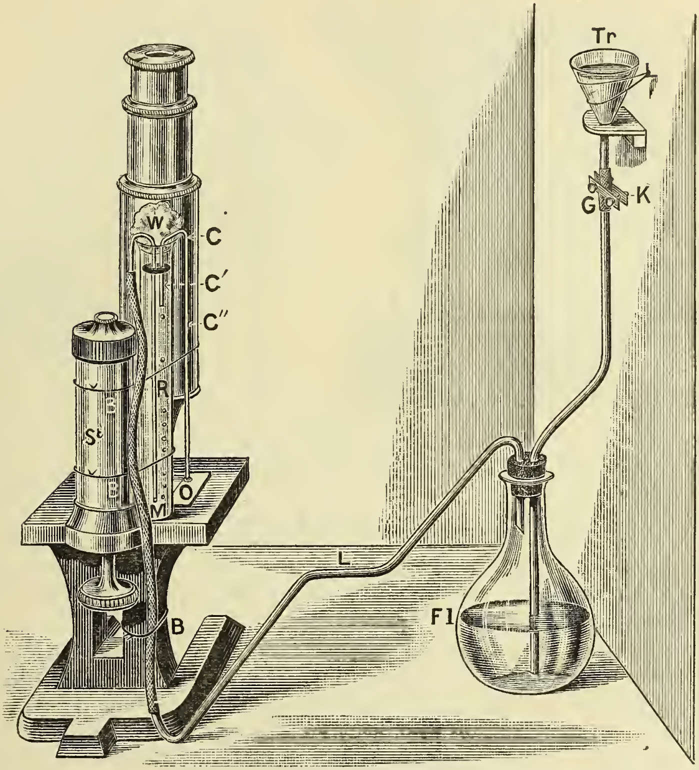
Apparatus for examining the developmental stages of Infusoria under the Microscope.†—Dr. L. Rhumbler devised the following apparatus for examining *Colpoda cucullus* and *C. Steinii* in hay infusion. To the vertical bar of the Microscope S*t* (fig. 12), is fastened a medium sized

* Behrens, Kossel, and Schiefferdecker, 'Das Mikroskop und die Methoden der mikroskopischen Untersuchung,' Band i., 8vo, Braunschweig, 1889, p. 53 (1 fig.).

† Zeitschr. f. Wiss. Zool., xlvi. (1888) p. 549. Cf. Zeitschr. f. Wiss. Mikr., vi. (1889) pp 50–1.

test-tube R filled with sterilized hay infusion. Two very fine capillary glass tubes C C′ C″ bent to a U shape are then placed in the test-tube. The longer leg of one rests close to the cover-glass on the slide O. This allows a very small quantity of water to flow down by capillary

FIG. 12.



action, and if it should be too much the excess may be removed by means of strips of blotting-paper placed on the other side of the cover-glass.

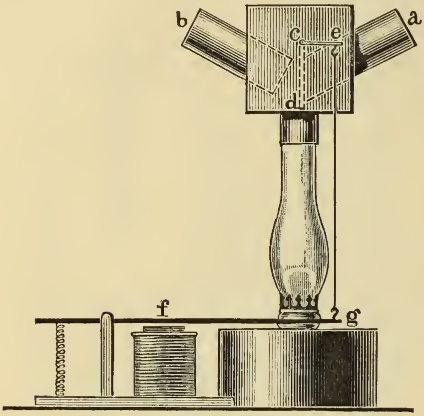
The rest of the arrangement is merely to supply air to the test-tube, as the infusoria tend to run towards the edge of the cover-glass if air be deficient. The water in the funnel T*r* presses the air from the flask through the tube L out of the capillary point M in the test-tube.

Thermostat with Electro-magnetic Regulator.*—N. Sacharoff has devised an instrument which is at the same time a modification and combination of Sahli and Scheibler's regulator (fig. 13). Upon the chimney of a mineral-oil lamp is placed a tin box, from opposite sides of which

* Protokoll. d. Kaiserl. Kaukas. Med. Gesell., 1888, p. 111 (Russian). Cf. Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 49–50 (1 fig.).

project two tubes *a b*, the ends of which nearly meet inside, and the direction of which is obliquely upwards. Above these internal openings is a transverse bar *c*, from which is suspended the valve *c d*, and this when hanging free covers the mouth of the tube *a*, and the heat escapes through *b*. When, however, *c e* is pressed down, the valve *c d* closes the aperture to *b*, and then the heat from the lamp escapes through *a*. If, therefore, a thermostat be connected with *b*, it can be warmed or cooled by the action of this valve. This action is governed by the electro-magnet. When the current is closed and the bar *f* drawn down by attraction, the latter pulls on *g e* and the valve closes *b*.

Fig. 13.



The opening and closing of the current is effected by means of a vessel filled with 500 g. of mercury. This vessel, which is placed within the water-mantle of the thermostat, has a narrow tube let into it. Within the narrow tube, and also in the vessel of mercury, are placed two platinum wires; these are connected with magnet and battery. When the temperature rises the mercury ascends in the narrow tube and reaches the platinum wire. Hereby the current is closed and the entrance to *b* also, and therefore the access of heat. As the thermostat cools the action of the valve is reversed and the heat again enters. The apparatus regulates to about 1/2°.

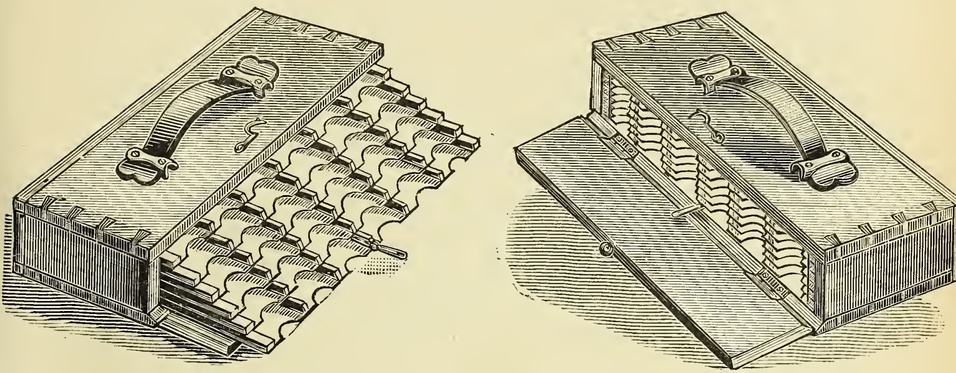
Kruticklij's Microspectroscope.*—Herr P. Kruticklij describes a micro-spectroscope which he invented sixteen years ago. Placed between the stage and the mirror it throws an objective spectrum on the slide, which is seen at the same time as the preparation examined. In order to facilitate the employment of any magnification which may be required, it is necessary to narrow the slit of the spectroscope in proportion to the magnification of the object. This is effected by screwing to the spectroscope an objective of the same power as that with which the object is observed. The spectroscope itself consists essentially of a combination of three prisms (two of crown-glass, the middle one of heavy flint-glass). The light is thrown from the mirror on to the slit (which is protected by a glass plate and can be narrowed to any extent by a screw), and is then concentrated by a lens on the prisms, dispersed by them, and thrown through the objective as a microscopically small spectrum upon the slide. The apparatus is provided with a divided ring, by turning which the slit is brought into the focus of the objective; and a contrivance to move the spectrum in a horizontal position in the field of view.

* Script. Bot. Hort. Univ. Imp. Petropolitanæ, ii., pp. 35–40, 1887–8. See Bot. Centralbl., xl. (1889) p. 10.

Moseley's Object-box.—This (fig. 14) is a new form of object-box invented and provisionally protected by Mr. E. Moseley.

The special feature of the box (which was exhibited at the November meeting by Messrs. W. Watson and Sons) is that, by drawing forward

FIG. 14.



the bottom tray all the others follow in series, displaying the labels of the slides. In the old form of object-box each tray has to be removed to pick out any object, but in Mr. Moseley's the object can be at once seen without any trouble. The box occupies no more space than the old form.

Maddox's Simple Substage Condenser.*—Dr. R. L. Maddox writes: —"On the supposition that the following remarks may be of interest, I beg to offer them to your notice. They are founded on the application of a rather novel kind of substage condenser for the Microscope, which has furnished me with some rather unexpected results, both visually and photographically. Whatever may be its real value, it has one claim which cannot be questioned, and that is its cost can be placed at zero. No doubt many of your readers have perused Professor Lowne's interesting article on "Interference Phenomena in Relation to True and False Images in Microscopy," reported in the Journal of the Quekett Microscopical Club for April of this year. Prof. Lowne suggests also a new theory for the formation of the diatom-image when it is brighter than the field, and that 'the cause of the positive image is that the diatom is illuminated from above, not from below. It is illuminated by reflected light from the upper surface of the front lens of the objective'; and the Professor cites an experiment showing the 'great illuminating power of the back of the front lens of an objective.' This surface of emergence of the front lens is a concave mirror, which condenses the reflected pencil upon the object. That such is the case to a certain extent is correct; but the following experiment will, I think, show it does not entirely suffice to form a bright image of the object in the case of diatoms. Having suggested to an eminent microscopist and photomicrographer the use of a cylindrical lens of short focus for a certain

* Brit. Journ. of Photography, xxxvi. (1889) pp. 812–3.

purpose, and even hinting at a trial with a small piece of thermometer-tube retaining the mercury-column, under the supposition of the correctness of the argument used by Prof. Lowne, thinking it might be possible that the bright, reflecting, flat surface of the mercury within the tube would aid the object in view by producing the desired image, I determined to test the same. At the time I was too unwell to carry out my suggestions, but I did so at the earliest moment, and my object in this article is to state the results.

The only properly constructed cylindrical lens I possessed was of too long a focus for the purpose, which was to try and render evident some doubtful markings, dots, lines, or areas on the diatom *Amphipleura pellucida*. To construct a short-focus cylindrical lens means more time and trouble than I could give, so I cut off a piece of a thermometer-tube 1/2 in. long and from 1/6 to 1/5 in. in diameter, and having sealed in the small column of mercury, I mounted it centrally in a thin flat piece of ebonite, as the first thing to hand. It was let into a slot diametrically, cut exactly to fit the tube lengthwise, keeping its surface parallel to the surface of the ebonite. The tube was thus held longitudinally at its widest diameter, the flat face of the little mercury-column showing above and beneath. It was in this extemporized setting fitted on the top of the brass tube of a substage condenser without its lenses, but having its own rackwork, and being capable of rotation in the centering of the substage of the Microscope. Here I had a kind of cylindrical lens formed round one axis of revolution, the central portion being blocked out by the small column of mercury. No time was lost to now test its value as a simple substage condenser for use on lined objects, and also as it appeared to me useful to test Prof. Lowne's theory. After duly centering the mercury column, I placed on the stage a slide with *Pleurosigma balticum*, and by aid of the plane mirror and daylight, using the 1/5-in. objective and No. 1 eye-piece, I noticed that the bright reflecting surface of the mercury in the little tube did not suffice to give by its own light, reflected from the back of the front lens, more than a very faint image of the diatom; but the moment the small tube was decentered, so as to place the mercury-column to one side, or just out of focus, I had a very beautiful image of the object, and could by rotation of the tube round the central axis of illumination easily bring out, separately, either the short horizontal lines or the longitudinal ones by alteration of this substage adaptation, or both, showing the markings or areas in squares. Another objective was tried, as Zeiss E, equal to about one-ninth. Here the image was more perfect, only from its larger numerical aperture there was less difficulty to separate the striation. The next trial was to go over the same ground again, using simply the divergent rays of the Microscope-lamp, and with the same result. The divergent rays were next made parallel by a bull's-eye condenser, also by a crossed lens before reaching the small tube, which rendered this image very bright.

Having thus far satisfied myself, I next cut a small piece from a solid glass rod of about the same diameter. This was mounted more carefully, and upon testing its use in the same manner, I was greatly surprised at its efficiency when used to illuminate the same object, and also other diatoms. The extreme brightness of the images with a 1/12 water-immersion made by Gundlach, and selected for me years since by

Mr. Winspear, optician, Hull, for photomicrography, when focused on *Pleurosigma formosum*, led me to test its value photographically. Unfortunately, I had to fall back on some old slow quarter-plates, and being without any guide as to exposure, I simply made use of my small camera arrangement, described in one of your almanacks, and attached it to the draw-tube of the Microscope, using for illumination a large paraffin lamp, and a crossed lens as a condenser. At the first trial a very fair image was obtained, using the developing solution described in the present 'British Journal of Photography Almanac,' 1890. It seemed evidently worth while to try another more magnified image, so I managed to centre a quarter-plate camera by means of a blackened card with a central dark-lined paper tube fitted to the draw-tube of the Microscope, and made to fill up the lens aperture in the camera. As soon as ready, I took a photomicrograph of *Pleurosigma formosum*, using the 1/12-in. bull's-eye condenser and lamp, the little rod being set parallel to one set of lines on the diatom. The result I inclose for your notice, as it possibly may be one of the first negatives you may have seen produced under such conditions. Unfortunately it is a trifle over-developed, but with the naked eye, or better with a lens, you will see the effect that can be obtained by such a simple piece of apparatus.

The value of the little rod as a condenser appears to me to rest chiefly in giving linear illumination of a convergent character, which can be directed in any position as regards the striation of lined objects. Some very curious effects can be brought out by keeping the eyes fixed on the object at the same time that the rod is gently rotated round the axis of the Microscope, and it is just possible some of the peculiarities in the structure of striated diatoms may be better brought out than with an all-round convergent illumination. There is one point that must be carefully observed to obtain the best result, which is to be careful to use it at its own focus, otherwise the image is pale or fogged. It is not pretended to offer this plan for anything more than a *costless* substitute for a *costly* piece of apparatus. It possesses a certain value, but is not intended to compete in general excellence with a first-rate achromatic substage condenser. You will be able to judge for yourself. I should have liked to have tested rods of coloured glass, but could not put my hands on any suitable; and there remains yet to try the rod with a right-angle prism, instead of the plane mirror or parallel light by means of the bull's-eye condenser. To find the best position of the rod requires a little trouble."

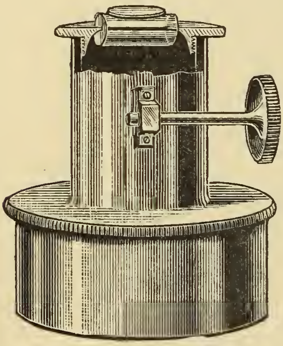
Maddox's Small Glass Rod Illuminator.—Dr. Maddox refers to the preceding as follows:—" In this age of rapidly advancing microscopy may I for a few moments crave the attention of the Fellows of the Society to the claims of a small piece, 1/2 in. long, of solid white or blue glass rod, about 1/5 or 1/6 in. in diameter, when used as an illuminator, and substituted for an ordinary substage achromatic condenser. I ask this permission as several errors have crept into the pages of a weekly contemporary journal, through the incorrect statements of a writer who noticed an article on the use of the white glass rod, contributed to the 'British Journal of Photography' of December 13th, 1889.

A few days since I mounted a piece of blue glass rod in the same manner, i. e. by fitting it horizontally at its widest diameter into a thin cell, which screws on the top of a substage fitting which has its own

rackwork, and this, when inserted into the substage support, is capable of being rotated; thus the centering, focusing, and position—matters of importance—are secured. By both plans I have been enabled to examine many lined objects, whether the appearance be due to ridges, or areas as elevations or depressions, and I have reason to suppose, if employed properly and patiently, either will render visible any markings any objective, at least of the old school, is capable of revealing.

The rod has been used with the 1/2, 1/5, 1/9, and 1/12 in. water-immersion, the latter photographically, the radiant being a small paraffin lamp, and between it and the rod a large No. 1 eye-piece, or a crossed lens, or a bull's-eye condenser. After numerous trials, preference was given to the first.

Fig. 15.



The white rod has also been made into an immersion illuminator by fixing on the top horizontal edge a small cover-glass (fig. 15). Two of the negatives accompanying this were taken by it used thus, as an immersion illuminator; the others by the blue rod, dry.

I have been rather surprised at the minutiæ either will reveal, as small bars of silex extending into the large areas in some of the fragments from the Oamaru deposit; the secondary markings in *Triceratium*, &c., are remarkably well shown by either rod, and they well define the areas in *Navicula rhomboides*, &c. It appears to act as a narrow convergent central line of light, which, by careful manipulation, yields at certain points of rotation, excellent definition.

Possibly what I have said will be called in question, but it must be understood I do not claim for the rod more than has been stated, and trust others, if induced to try it, may find it has not been exaggerated."

(4) Photomicrography.

Photomicrography.*—Dr. Th. Kilt reviews the history of photomicroscopy and the present condition of its technique. He describes in detail the apparatus of Zeiss and Klönne and Müller, light-filters, and orthochromatic plates; the various copying methods are thoroughly discussed. The specimens of photography given by the author show the great superiority of this method over drawing, and it is safe to prophesy that if the improvements of this art can be continued, it will soon sweep the field for bacteriological and histological illustrations. Although, from motives of economy, photozincography, which only imperfectly reproduces the delicacy of the negative, was selected, the illustrations given are extremely clear and sharp.

Silver Combinations of Eosin.†—Dr. E. Zettnow finds that the orthochromatic power of eosin-silver plates is due to the erythrosin or its silver combinations, and not to the eosin. The erythrosin plates

* 'Encyklopädie d. gesammt. Thierheilkunde u. Thierzucht,' Wien u. Leipzig, 1889. Cf. Zeitschr. f. Wiss. Mikr., vi. (1889) p. 193.

† Zeitschr. f. Wiss. Mikr., vi. (1889) p. 193, from Photogr. Correspondenz, 1889.

are moreover extremely sensitive to yellow, and as long as this kind of light predominates, the excellence of their delineation is unsurpassable. By their aid sharp negatives can be obtained with a mineral oil lamp and the ordinary low-power objectives, and this without a filter. With sunlight, or as soon as the light becomes impregnated with many blue rays, they fail.

(5) Microscopical Optics and Manipulation.

Amphipleura pellucida and Pleurosigma angulatum.—Dr. H. Van Heurck sent for exhibition at the December meeting some remarkable photomicrographs of *Amphipleura pellucida* and *Pleurosigma angulatum* taken with the new Zeiss's 1/10 in. objective of 1·63 N.A.

Monochromatic sunlight was used. Medium for the preparations 2·4. For those of *Amphipleura* moderately oblique light was used with magnifying powers of 2000 and 3000 diameters. The *Pleurosigma* photographs were taken with strictly axial light and a small aperture of the diaphragm, the magnification being 3000, 10,000, and 15,000.

The photographs of *Amphipleura* show the valve completely resolved in beads (cf. *supra*, p. 91), while those of *Pleurosigma* show details not hitherto observed.

Dr. Van Heurck considers that his "conclusions as to *Pleurosigma* are now complete and positive and may be summed up as follows:—

(1) The alveoles of *P. angulatnm* are hexagonal, at any rate in the place where the two layers of the valve unite.

(2) The intermediate beads are produced by bad focusing of the angles of the alveoles."

The following is a translation of a communication made by Dr. Van Heurck to the Belgian Society of Microscopy:—

"I have the pleasure to submit a new series of photographs of *Pleurosigma angulatum* obtained with the 2·5 mm. objective 1·63 N.A.

On studying this diatom attentively, I observed a very singular appearance; the alveoles or beads showed themselves in the form of very minute points, and were surrounded by a ring of six secondary beads when each alveole was viewed separately. If, however, the whole valve was viewed it was seen that the secondary beads were really intermediate between two principal adjacent layers of the valves.

I thought at first that this appearance of structure was new, but later I saw that a similar appearance existed on the margin of the valve photographed by Dr. R. Zeiss (5000 diameters), and which is figured in his 'Atlas of Photomicrography.'

Photograph No. 1 reproduces the above appearance. No. 2 shows it under a power of 10,000 and with an exact focus. In No. 3 the focus was purposely altered so as to show the secondary beads better.

How is this structure to be explained?

If the photograph No. 2 is attentively observed it will be seen that the alveoles are not round as has been generally believed in modern times, but that they present sensible angles.

An absolutely exact focus (photograph No. 4) shows that the opinion of the old microscopists was well founded and that the alveoles are really hexagonal.

This hexagonal form being admitted, an easy explanation is obtained

of the secondary beads, which are produced by the imperfect focusing of the angles of the network, that is, by the places where two lines run into one another. To verify this hypothesis I have studied with the same objective a great number of large diatoms where the structure allows of no doubt, and I have found in *Coscinodiscus excentricus* the confirmation of my assertion.

The structure of this diatom is well known. With low-power objectives it is seen to present large hexagons. The valve is very convex, and by regulating the focus suitably we can obtain at the same time all the appearances from the real hexagons to the isolated point surrounded by six illusory intermediate beads. It is this which is shown in photograph No. 5.

The last photograph, No. 6, shows that the valve of *Pleurosigma* is formed of two layers, and that the alveoles are hollowed out in the substance of the valve. The photograph shows a valve where the lower layer bears, on a part of the surface only, a fragment of the upper layer. The hexagonal form of the alveoles is seen round the median nodule. It may therefore be considered that the form of the alveoles is hexagonal at the point of union of the two layers, and that each alveole terminates above and below very gradually in the form of a dome. This is what my latest researches seem to demonstrate. I hope to be able, as soon as I have leisure, to send photographs in support of this view.

List of photographs:—

1. *Pleurosigma angulatum* W. Sm. × 3000.
2. Ditto—exact focus on the intermediate illusory beads—about × 10,000.
3. Ditto—out of focus, to show the intermediate beads better—about × 10,000.
4. Ditto—focus on the hexagon—about × 15,000.
5. Ditto—showing partially the two layers of the valve.
6. *Coscinodiscus excentricus*."

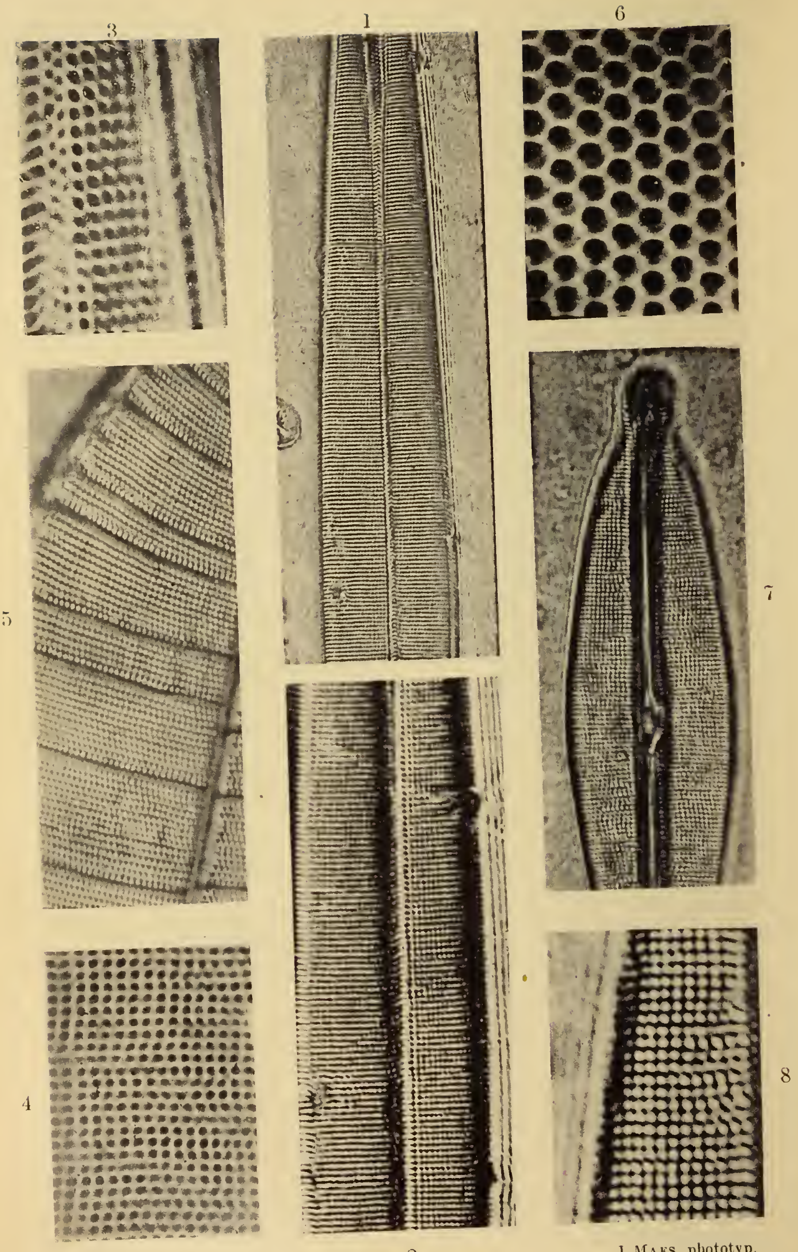
Structure of Diatom Valves.—Dr. Van Heurck also sends us the following paper:—

In my 'Synopsis of Diatoms' I showed that in the large *Crypto-Raphides*, for instance, *Coscinodiscus*, we can clearly distinguish three parts: an upper membrane, a lower membrane, and an intermediate layer, and these may be identified when isolated, either wholly or partially, in certain gatherings.

We know from Prof. Abbe's theory that the Microscope *alone* does not enable us to determine with certainty the structure of minute forms. But though technical means fail us, we can still make estimations by analogy as we do in most of the sciences. The study of large forms authorizes us to infer that the structure of the more delicate forms may be identical or at least very similar.

It has frequently happened that the examination of favourable fractures has enabled me to confirm these views, and they have also been confirmed by careful observers, such as Deby, Cox, and others. The portion of the intermediate layer photographed by Mr. T. F. Smith, and figured as No. 5 in his note on the *Pleurosigma* valve, is a case in point that may be considered quite conclusive.

The more recent and powerful optical means placed at our disposal by the house of Zeiss, of Jena, allow us to go a step further in the study



Dr. H. VAN HEURCK, phot.

J. MAES, phototyp.

1-3. AMPHIPLEURA PELLUCIDA KÜTZ. — 4. A. LINDHEIMERI GRUN.
5. SURIRELLA GEMMA EHR. — 6. PLEUROSIGMA ANGULATUM W. SM.
7-8. VAN HEURCKIA CRASSINERVIS BREB.

C. Zeiss. Object. 2,5 N.A. 1,63 — Ocul. 12 — Cond. N.A. 1,60.
Lumière solaire monochromatique.
Oct.-Nov.-Déc. 1889.

of the valve, firstly, in producing an optical image which is more complete and hence more real, and further by reducing more nearly to a mathematical plane the portion of the valve that can be seen with one and the same focal adjustment.

The new results obtained and confirmed by photography—which all serious observers now regard as the best criterion—still further simplify our opinions, and enable me to summarize them as follows :—

(1) Diatom valves consist of two membranes or thin films, and of an intermediate layer, the latter being pierced with openings.

The outer membrane, which is often very delicate, may readily be destroyed by the action of acids in cleaning, or by friction, &c. It may be also that this membrane exists only in a very rudimentary state. Specialists on this subject are generally agreed in supposing that these membranes may be sufficiently permeable to allow circulation by endosmose from the interior to the exterior of the valve, though they have no real openings during the life of the diatom and whilst it remains intact.

(2) When the openings of the interior portion are arranged in alternate rows, they assume the hexagonal form; when in straight rows, then the openings are square or oblong.

The hexagonal form, which occurs so frequently in nature, seems to be the typical form of the openings in the interior portion, and this form obtains mostly in large valves, which are not otherwise provided with strengthening ribs. Even in the forms having square openings we frequently perceive deviations, and the tendency to recur to the hexagonal type on certain portions of the valve. It may be that the interior consists of several layers superposed, formed successively and very closely joined, but so far I have not met with any form exhibiting superposed layers differing from each other in type.

This description seems to me to represent in broad outline the structure of diatom valves. But this structure may appear complicated, either by the presence of secondary internal valves ("Regenerationshülle"), or by deposits of silica on various parts of the valve. These deposits originate the "thorns" met with in divers forms (such as *Triceratium*), the rings found on the under membrane of certain forms of *Coscinodiscus*,* and the anastomosed ribs of *Navicula aspera* Ehr. (*Stauroneis pulchella* W. Sm.†) &c.

All these deposits are merely secondary silicious products which have nothing to do with modifying the general structure of the valve in its primordial elements.

Description of the Plates.

Plate II.—(1) *Amphipleura pellucida* Kütz. resolved into beads × 2000. The insufficient magnification shows a good general view, but the beads are not so sharp in the print as in the negative.

* I have observed the rings in *Pleurosigma formosum* referred to by Mr. T. F. Smith, but the new objective (1·63 N.A., medium 2·4) when employed on valves that were purposely broken, shows them lying flat on the under membrane, precisely as in *Coscinodiscus*. Possibly these rings are portions of secondary valves. I have not been able yet to determine the point.

† The valves of *Navicula aspera* Ehr. appear at first sight very complicated, and they have hitherto been erroneously figured by all writers. My latest examinations would show that the appearances observed are due to the mixing up in vision of more or less distinct views of ribs or thickenings regularly anastomosed so as to form rings more or less alternate.

2. *ib.* × 3000.

3. *ib.* × 8000, upper part of the valve, showing square beads identical with those of *Amphipleura Lindheimeri* Grun.

4. *Amphipleura Lindheimeri* Grun. × 2500.

5. *Surirella gemma* Ehr., about ×1000.

6. *Pleurosigma angulatum*, in hexagons, about × 10,000.

7. *Van Heurckia crassinervis* Bréb. (*Frustulia saxonica* Rabh.) × 2 00.

8. *Van Heurckia crassinervis*, Bréb., about × 6000.

In all the photographs the focus was upon the intermediate layer, and here and there in most of them the gradations of form are shown between squares and hexagons.

Plate III.—*Pleurosigma angulatum* W. Sm. × 2000. On the right of the centre the illusory intermediate beads are seen at the same time as the real beads (the openings), of hexagonal form.

The photographs were all produced with Zeiss's new apochromatic 1/10 in. of 1·63 N.A. Monochromatic sunlight. Compensating eye-piece (special) 12. Condenser 1·6 N.A.

The preparations were all in a medium of 2·4. Cover-glass and slides of flint, 1·72. Diatoms melted into the cover-glass softened by heat.

Ilford dry plates, developed with hydroquinone and eosine solution as supplied by Mercier, of Paris.

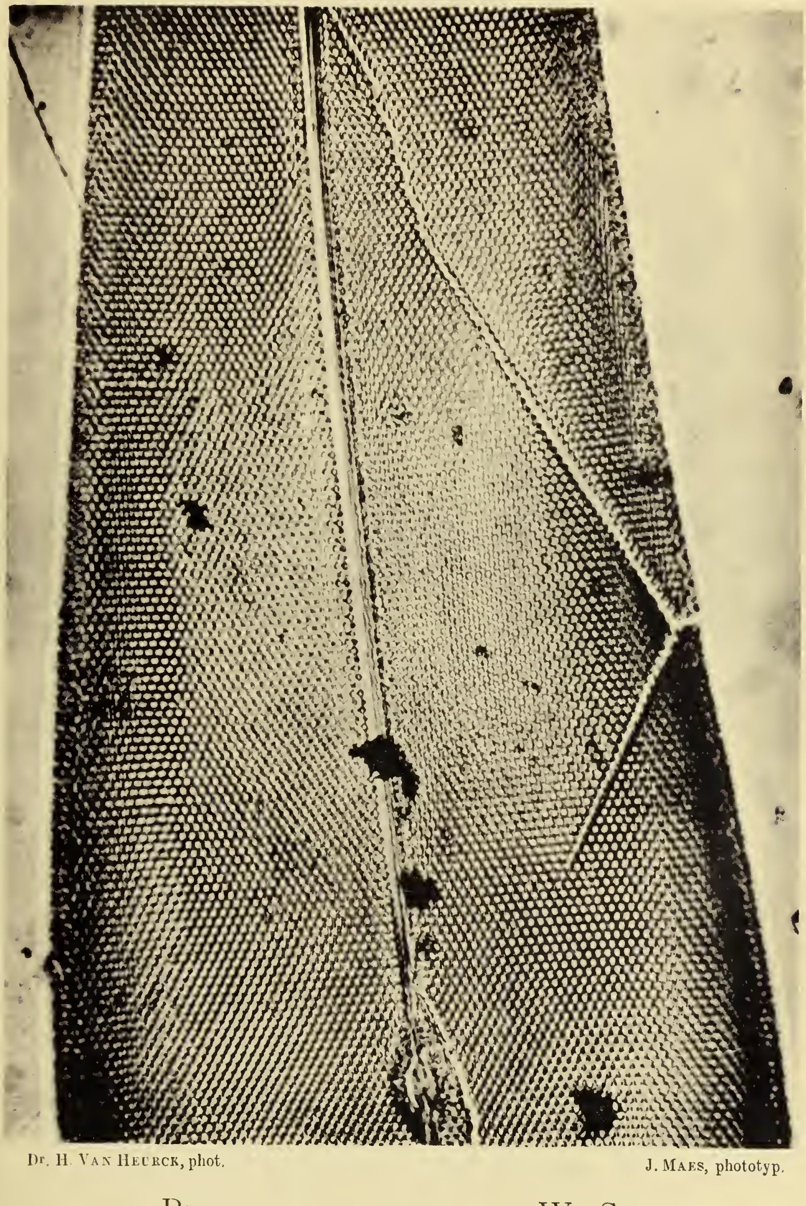
Resolving Power a "Superfetation."—The following extract from M. A. Zune's 'Traité de Microscopie' (1889) should be interesting to microscopists.

"Resolving power. We regret not to have the necessary authority to erase this word from the dictionary of microscopists, since it appears to us to constitute an entire superfetation. To say of an objective that it has resolving power is, according to most authors, to attribute to it the power of isolating so to say one from another the finest details of structure on the surface of a transparent object such as striæ, fibrillæ, depressions, reliefs, &c.; but an objective which defines well in the complete sense of the word, ought it not to resolve perfectly?"

This carries a long way further the error on which we commented in the case of the Quekett discussions, where, however, it was not proposed to abolish the term "resolving power"! As we explained then, and shall probably have to repeat again, an objective may have perfect defining power, and yet, by reason of its want of aperture, it will be unable to show particular markings. It defines all that it can take up, but cannot define what is not imaged by it.

It would be possible, no doubt, to arrange that "definition" should be considered to include "resolving power," but nothing would be gained by confusing the two terms, especially as we have already the term suggested by Prof. Abbe—delineating power—to denote the combination of the two qualities, an objective having large delineating power when it both defines well and has large aperture.

The author's views are in other respects peculiar, as he is of opinion that "an objective of large angle, *well constructed*, will—all other things being equal—show details in depth as well as it will show those on the surface."



Dr. H. VAN HEURCK, phot. J. MAES, phototyp.

PLEUROSIGMA ANGULATUM W. SM.

C. Zeiss. Object. 2,5 N.A. 1,63 — Ocul. 12 — Cond. N.A. 1,60.
Lumière solaire monochromatique.
Novembre 1889.

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(6) Miscellaneous.

Paris Exhibition, 1889.—The following English opticians obtained rewards at the last Paris Exhibition, though not necessarily for Microscopes alone:—

Grand Prize.—Messrs. Ross & Co.

Gold Medals.—Mr. J. H. Dallmeyer, Mr. J. Pillischer, and Messrs. Watson & Sons.*

Carlisle Microscopical Society.—The official report which we have received embodies a *résumé* of the work done by this vigorous provincial Society since its foundation in the year 1881, and especially since its affiliation with the Royal Microscopical Society in 1883. The Society was inaugurated by a public address delivered to a large audience by its first President, the Rev. Canon Carr, who afterwards gave a series of educational papers on Vegetable Histology. Papers have been read at successive meetings by various members of the Society on such subjects as the adulteration of food, water, coal fossils, trichina, diseases of plants, animal physiology, photomicrography, the Microscope in manufactures, slide-mounting, and others too numerous to mention. Frequent excursions have been made by the Society to collect material for microscopical examination. Two public lectures have been delivered to crowded audiences by the Rev. Dr. Dallinger, and one by Sir Robert S. Ball, Astronomer Royal for Ireland, who has also promised to give another in the course of the present session. The aim of the Society has been eminently a practical one, and much earnest work has been done. The President of the Society is C. S. Hall, Esq., and the Hon. Vice-Presidents, Prof. Pasteur and the Rev. Dr. Dallinger.

Orthography of the Microscope.—There is no word which is so variously spelt as "Microscope" or (with "microscopical," &c.) so often misspelt by printers.

The form "Miscroscope" occurs times out of number.

The Germans, apart from the standard form of "Mikroskop," also spell it "Mikroscop," "Microskop," and "Microscop."

"Microscrope" appears in Proc. Amer. Soc. Micr., 1886.

"Mikrospischen" is found in Stenglein's 'Anleitung,' 1887.

"Miroscopical" in Amer. Mon. Micr. Journ., viii. (1887) p. 49, and this Journal, 1887, p. 1039.

"Microscopial" in 'The Microscope,' 1888, p. 108.

"Mikrokopiker" in 'Flora,' 1888, p. 39.

Mr. Crisp and this Journal.—The 'Athenæum' says:—"Microscopists, abroad as well as at home, will hear with great regret that Mr. Frank Crisp is about to resign the office of Secretary to the Royal Microscopical Society, which he has held for twelve years. During that period the character and position of the Society have been greatly improved, and the numerous microscopical societies which have sprung up elsewhere have come to regard it as their common parent; the number of its Fellows has been doubled, and its Journal has been converted into one of the most useful aids to research which are now put into the hands

* Cf. Journ. d. Microgr., xiii. (1889) pp. 481–93, and Mr. J. Mayall, junr., this Journal, 1889, pp. 851–2.

of working biologists. For twelve years this Journal has averaged a thousand pages in each volume, and its circulation is understood to be more than one thousand copies. This result, it is generally known, has only been obtained by the yearly expenditure of a sum of money larger than the annual income of the Society; Mr. Crisp's banker alone, in all probability, knows how large that sum is. But Mr. Crisp has not only given money; he has also devoted a large amount of time to editing and improving the character of the Journal, and by his own contributions and criticisms has done a great deal in making intelligible to microscopists the modern theories of the Microscope. His retirement from, no less than his election to, the office which he holds marks a critical period in the history of the Society. But though his legal duties are so much increased as to leave him no choice, he will still be intimately associated with the Society, as he is willing to act as its Treasurer, and we may be sure that his interest in it is in no way abated." *

β. Technique.†

(1) Collecting Objects, including Culture Processes.

Cultivation of Actinomyces.‡—Dr. Kischensky inoculated blood-serum and agar to which 6 per cent. of glycerin had been added with actinomyces granules. The next day evidences of growth were observed. In the course of a few days filaments associated with coccus forms were seen under the Microscope, and after two or three weeks the ends of the filaments were observed to possess bulb-shaped expansions (involution forms). In cultivations on potato the fungus grew in the form of yellowish granules. In gelatin at 39° C. the filaments seemed to grow in a radiate way, and sometimes showed bulbous expansions at their ends. The filaments were easily stained by Gram's method.

Whether these cultivations were really pure cultivations of actinomyces seems doubtful at present, as inoculation experiments were not tried.

Pure Cultivation of Actinomyces.§—For some months past, says Dr. O. Bujwid, "I have easily obtained pure cultivations of actinomyces, and have further ascertained the important fact that it is an anaerobic fungus."

The method adopted by the author was to take some of the granules from the abscess-pus of a person suffering from actinomycosis and cultivate them in ordinary gelatin, ordinary and glycerized agar, sterilized milk and potato at a temperature of 36° C. For some of the tubes 10 per cent. pyrogallic acid was used to absorb the oxygen (Buchner's method).‖ In these anaerobic cultivations the points inoculated were observed to have swelled in about 48 hours, while the rest of the tubes only showed copious growth of *Staphylococcus aureus*, *S. albus*, and some sort of rodlet.

* Athenæum, 1890, Jan. 11, p. 53.

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

‡ Arch. f. Experimentelle Pathol. u. Pharmakol., xxvi. (1889) p. 79.

§ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 630–3 (2 photos.).

‖ See this Journal, 1888, p. 1039.

The granules increased in size and in a few weeks had become pretty large yellowish-white grains which penetrated within the substance of the agar so that they could only be removed with difficulty. Microscopical examination afterwards showed that the colonies grew radiately, forming branches and mycelia like some moulds do, whence it would seem highly probable that *Actinomyces* is a sort of mould fungus. This appearance does not resemble that of the club-shaped elements found in human pus and in the fresh pus and nodules of ruminants, but is identical with that of the nodules found in human organs or in human pus after treatment with caustic soda.

In older agar cultivations bulb-shaped expansions formed on the ends of the filaments, but whether these were gonidia or an involution form the author cannot yet say.

Two photographs from sections magnified 340 and 840 times were obtained as follows:—An agar cultivation three weeks old was cut up into small pieces and placed in absolute alcohol for 48 hours; then for 24 hours in 1 per cent. and afterwards for six hours in 5 per cent. photoxylin solution. From these pieces sections were made in the usual way and removed from spirit to a slide, and when they were dry (20–30 minutes) were stained by Gram's method. The photographs were taken with Zeiss's apparatus by sunlight. Zettnow's light-filter was used and Attout-Tailfer's isochromatic plates.

Cultivation of Typhoid Bacillus in Sewer Water.*—M. L. Olivier states that sewer water is a very favourable medium for the cultivation of typhoid bacilli; they develope in it quite as well as in bouillon.

(2) Preparing Objects.

Preparation of Cells for showing the Division of Nuclei and the Formation of Spermatozoa.†—For examining cell-fission, and the formation of semen in the hermaphrodite glands, Dr. G. Platner recommends immersion in the strong Flemming's mixture. Fresh pieces of gland cut up small, if necessary, are placed in the mixture for an hour; the fluid is then diluted with three or four times its bulk of water, and allowed to harden further for 24 hours longer. They are then thoroughly washed in the usual manner, and afterwards transferred to spirit of increasing strength. The best nuclear stain is logwood, and the author recommends Apáthy's modification of Heidenhain's hæmatoxylin (hæmatox. crystals 1, absolute alcohol 70, aq. dest. 30, the fluid to be kept in dark-coloured bottles).

The objects were stained *in toto* for 24 hours, and afterwards acted on by a 1 per cent. alcoholic solution of bichromate of potash. This solution is made by mixing 10 parts of bichromate with 300 of distilled water, and then, when required, diluting 30 ccm. of it with 70 ccm. of strong spirit. This gives the proper colour after acting for 12 hours. If a lighter stain be desired, it must work for 24 hours. The objects are then transferred to 70 per cent. spirit, and kept in the dark for one or more days. After this they are dehydrated in absolute alcohol, and

* Comptes Rendus Soc. Biol. Paris, 1889, No. 27; Centrabl. f. Bakteriol. u. Parasitenk., vi. (1889) p. 519.

† Arch. f. Mikr. Anat., xxxiii. (1889) pp. 125-52 (2 pls.).

then soaked in cedar oil. They are next soaked in paraffin for 20 minutes. The series of sections are stuck on the slide with castor-oil collodion, and after the removal of the paraffin with xylol, mounted in balsam.

For studying the division of the nuclei in the Malpighian vessels of *Dytiscus marginalis*, the author used Kleinenberg's picrosulphuric acid for hardening. This was found specially advantageous in that it decolorized the dark-brown granules which beset the cell-plasma.

By staining with borax-carmine and then treating with acidulated alcohol, a beautiful colour was obtained.

Preservation of Mucous Granules in Secretory Cells.*—Mr. J. N. Langley advises the following method for preserving mucous granules in secretory cells. The animal is killed by bleeding or decapitation. A small piece is then snipped off a salivary gland, the piece having been previously pierced with a threaded needle. The piece of gland is suspended by the thread in a bottle, which contains some 2 per cent. osmic acid. The thread is fixed between the stopper and neck of bottle, and the piece of gland hangs just above the level of the fluid. The object is hardened in about 24 hours. It is then removed, washed for a few minutes in water, and then for 15 minutes apiece in 30 per cent. and 50 per cent. spirit. Next, for half an hour apiece in 75 and 95 per cent. alcohol; finally for one or two hours in absolute alcohol. The preparation is then soaked for half to one hour in benzol previously to being imbedded in hard paraffin. The series of sections are fixed on the slide with albumen stained with methylen-blue, and mounted in balsam. Or the paraffin may be dissolved out by means of benzol or turpentine. This method is said to give good results with mucous cells from the mucosa of many of the lower vertebrata.

Removing the Jelly and Shell from Frogs' Eggs.†—The method for removing the coverings from frogs' eggs recommended by Prof. F. Blochmann is essentially the same as that previously advocated by Prof. C. O. Whitman.

The author employs eau de Javelle, a solution of hypochlorite of potash, while Whitman used sodium hypochlorite. The ova which have been preserved in chrom-osmium acetic acid, and been well washed in water, are placed in the solution, twice or thrice diluted, and then shaken up by inverting the vessel. The eggs, freed from their gelatinoid coat, sink to the bottom in 15 to 30 minutes. They are then very carefully washed in water, and afterwards transferred to strong spirit. If the eggs be kept in the dark the chromic acid is removed more effectually. The author recommends borax-carmine for staining. Hæmatoxylin is not suitable.

Carbonate of Ammonia for demonstrating Sarcolemma.‡—Prof. B. Solger recommends a cold saturated solution of ammonia carbonate for demonstrating the sarcolemma of frog's muscle. In this solution the muscle is placed for 3 to 5 minutes, and having been teased out, examined under the Microscope. The reaction is more complete if the animal be previously kept for several weeks in captivity.

* Journal Physiol., x. (1889) pp. v. and vi.
† Zool. Anzeig., xii. (1889) p. 269.
‡ Zeitschr. f. Wiss. Mikr., vi. (1889) p. 189.

Demonstrating the Neurokeratin Network of Nerve-fibres.*—Dr. G. Platner advises the following procedure for demonstrating the neurokeratin network.

Thin fresh pieces of nerve, freed from connective tissue and fat, are placed in the following solution—Liquor ferri perchloridi 1 part, distilled water or rectified spirit 3–4 parts. In this the pieces of nerve are left for days to weeks. The iron chloride is then to be thoroughly washed out so that no trace of iron can be chemically detected in the water or spirit. After this the pieces are to be kept till wanted in spirit.

The best stains for nerves thus manipulated are "Echtgrün," a dinitroresorcin which in combination with the iron still remaining in the tissues gives a green colour, and alizarin, which imparts a deep violet hue.

To use dinitroresorcin, a supersaturated solution of the solid pigment is made in 75 per cent. alcohol. In this solution large pieces of tissue require to lie for several weeks. When thoroughly freed from iron the immersed pieces gradually become dark green, but the fluid itself exhibits no trace of green. After having been dehydrated, the pieces are imbedded, and sections, both longitudinal and transverse, made. In transverse section, the axis cylinder is stained a dark emerald green, and from this radiate outwards to the medullary sheath, numerous green delicate filaments, the neurokeratin network. In longitudinal section the same network is shown.

The stain is fairly resistant to acid and alkaline reagents, and the different methods of hardening do not exclude the use of the perchloride solution.

Preparing the Silk-glands of Araneida.† — Dr. C. Apstein, in making a macroscopical examination of the living animal, opened the body under water and then removed the heart, intestine, liver, and organs of generation. An addition of some drops of sublimate to the water imparted to the previously glass-like spinning-glands a milky appearance. Alcohol-material was prepared under 35 per cent. spirit. For sectioning the author prepared the animals with hot water, boiling them from 1/2–3 minutes, according to size, and then imbedding in paraffin, after passing them through turpentine or chloroform. The author cautions against using cedar-oil, as it is a poor solvent of paraffin. Borax-carmine, and after-staining with hæmatoxylin, are recommended for staining.

The statement that the silk-threads of the glandulæ pyriformes consist of a double substance is interesting, since the secretion from the upper part of the gland forms a solid non-staining cord, while the cells from the lower parts of the glands secrete a tubular filament which is clearly stained. The author verified this in different species.

Preserving Actiniæ.‡ — Dr. J. P. M'Murrich recommends the collector of Actinians who has not the time to properly carry out the narcotizing methods to act as follows. After noting general characteristics, place the animal in a jar just wide enough to allow of its complete

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 186–8.
† Inaugural-Dissert. Kiel, 1889. Cf. Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 199–200.
‡ Journal of Morphology, iii. (1889) pp. 2–3.

expansion, and with just enough water to cover it when fully expanded. A glass syringe filled with Perenyi's fluid should have its nozzle quickly inserted into the mouth of the Actinian, and the contents should be rapidly injected. At the same time, if possible, a quantity of the same fluid should be poured over the animal. After half an hour the animal should be treated successively with 50, 70, and 90 per cent. alcohol, care being taken to inject a considerable quantity of the spirits into the interior at each change. Though considerable contraction and loss of colour ordinarily follow the use of this method, the parts are satisfactorily preserved for future histological study.

Demonstrating Cyclosis in Vallisneria spiralis.*—Prof. S. Lockwood says that Mr. F. W. Devoe is able to show the circulation in this plant to the best advantage. "Having selected a bit of a leaf, not too mature, he shaves off one side with a sharp knife, although a razor is better. It is then put on a slide, the shaven side up. A drop or two of clean water and a cover-glass of medium thickness with good illumination follows, Mr. Devoe using a prism illuminator. Begin with a 6/10 objective, and continue to a 1/6 or a 1/10, and a vision is got of a startling clearness. The vivid individuality of each bioplasmic molecule and the mystic, almost solemn movement of this pellucid stream of infinities of life, form a sensational picture of which the beholder never tires."

Cleaning Diatoms from Sand.†—Mr. Norman N. Mason communicates the following method:—

After removal of the organic matter with acid by the usual methods, add to the diatoms and sand in a large bottle, thirty, forty, or fifty times the quantity, by measure, of water, and gently shake until they are mixed. This water, with the diatoms and sand kept suspended by an occasional shake, is slowly poured in a small stream upon the upper end of a strip of clean glass, 3 ft. long by 3 in. wide, and securely supported. The upper end of the glass should be from 1/8 to 1/4 in. higher than the lower end, and the glass should be level transversely. Beneath the lower end place any convenient receiver. The water and diatoms will pass into the receiver. The sand, which will form little bars on the glass, must be removed occasionally, as it gradually creeps towards the lower end of the glass, and there would eventually pass into the receiver.

The loss of diatoms will be very small. Usually one pouring is sufficient for cleaning. The sand can be re-washed if necessary, or a little clear water run over the sand on the glass strip will carry forward almost the last diatom; but this will scarcely pay for the trouble. A short piece of glass will cause a failure, and too great an incline will be found almost as bad.

Preparing Crystals of Salicine.—Dr. F. L. James a few years ago ‡ described a phenomenal class of crystals produced from salicine. The process is now stated § to depend on bringing a saturated solution of salicine made with distilled water in contact with cold below the

* The Microscope, ix. (1889) pp. 327–8.
† Journ. New York Micr. Soc., v. (1889) p. 116.
‡ See this Journal, 1887, p. 507. § Amer. Mon. Micr. Journ., x. (1889) p. 214.

freezing-point, and the explanation is, that the rapid congelation of the water interferes with the usual arrangement of the crystals, producing a wonderful series, which are entirely unlike any forms resulting from crystallization at the ordinary temperature.

(3) Cutting, including Imbedding and Microtomes.

Dextrin as an Imbedding Material for the Freezing Microtome.*—Mr. T. L. Webb says that by taking an aqueous solution of carbolic acid (1 in 40) and dissolving therein sufficient dextrin to make a thick syrup, a medium is obtained which is superior to the time-honoured gum and sugar in three ways. It freezes so hard as to give a firm support without being too hard. It keeps better than gum. It is much cheaper, costing only 4*d.* a pound, whilst powdered gum acacia costs 5*s.* Dextrin dissolves but slowly in cold water, so that a gentle heat is advisable when making the mucilage.

Imbedding in Celloidin.†—Dr. A. Florman recommends the following procedure for imbedding pieces of animal tissue in celloidin so as to obtain thin sections. After hardening the tissue in absolute alcohol, pieces about 3 mm. thick are placed for some hours in absolute alcohol, and after this in a test-tube containing a mixture of 3 parts ether and 1 part alcohol. In a couple of days some celloidin solution is added until the mixture is about as thick as a thin syrup. Herein the pieces remain for 14 days or longer, when more celloidin is poured in to make a thicker solution. After 4–8 days the contents of the test-tube are turned into a shallow glass capsule, wherein the celloidin solution must form a layer of 10–12 mm. thick over the preparation. The pieces having been arranged in the desired position, the capsule is covered with a glass plate, a cover-glass being interposed so as to allow of slow evaporation of the celloidin solvents. In 2 or 3 days' time a consistent mass free from air-bubbles is obtained, and from this the pieces are cut out so that each is surrounded by a layer of celloidin at least 3 cm. thick. When removed their under surface is to be daubed over with a thick solution of celloidin, so as to make all the surfaces of the same width. The pieces are replaced in the capsule to allow the new layer to become consolidated by evaporation of the ether and alcohol. Pieces thus prepared will have the consistence of cartilage, and sections from a block the sides of which are 1·5 cm. can be made 0·015 mm. thick, and if the area of the surface be decreased, still thinner.

Manipulation of Celloidin.‡—The failures that some microtomists experience when dealing with celloidin are due, says Dr. S. Apáthy, to the neglect of a few slight artifices. Commercial celloidin in plates or in shavings should be first of all thoroughly dried in the air, whereby it is rendered hard, transparent, and yellowish. Pieces of celloidin thus hardened are put into an air-tight vessel and just covered with a mixture of equal parts of sulphuric ether and absolute alcohol. After having been allowed to stand for some time with frequent stirring, the supernatant fluid is decanted off. This may be called the original or No. 1 solution. Some of this, diluted with an equal volume of equal

* The Microscope, ix. (1889) pp. 344–5, from the 'National Druggist.'
† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 184–6. ‡ T. c., pp. 164–70.

parts of ether and alcohol, forms solution 2, and some of solution 2 similarly treated forms solution 3. The preparation is placed for 24 hours or longer in each of these solutions successively. For consolidating the celloidin flat glass capsules are to be used. In these the objects are placed, and the capsules filled to the brim and covered over for some hours with a glass plate, in order that by preventing the surface from becoming hardened any air-bubbles may be allowed to escape. The glass plate is replaced in the course of some hours by a bell-jar, and in 6–24 hours, when a hardish film has formed upon the celloidin surface, the capsule is filled up with 75 per cent. spirit. In 24 hours the celloidin is fit for sectioning. From the glass capsule the pieces are cut out and stuck with a *thick* solution of celloidin on elder-pith. The celloidin block should be broader than high, and the under surface scratched with a needle. The elder-pith and celloidin are to be firmly pressed together, and then placed in 70 per cent. spirit.

For cutting sections from these blocks the knife should be smeared with yellow vaseline, and during the act of sectioning moved as nearly parallel as possible.

(4) Staining and Injecting.

Benzoazurin and Benzopurpurin Stains for Microscopical Purposes.*—Dr. Martin employs benzoazurin in watery dilute solution. The sections are overstained (1–4 hours, according to thickness of section or strength of solution). The sections are then decolorized with spirit acidulated with 1/2–1 per cent. hydrochloric acid. If a nuclear stain be desired, this effect may be counted on if the section be withdrawn when the celloidin is blanched. If the tissue elements are also to be dyed, then the decolorizing action must be interrupted earlier. A beautiful blue nuclear stain is thus obtained, and this is quite as distinct and sharp as that from carmine or logwood. This pigment seems, from the author's account, to be very useful for epithelial cells, where it brings out the nucleus and the contour of the cell, and also for most connective-tissue elements.

This dye seems to possess two valuable properties. The first is that old spirit-preparations are stainable with comparative ease; this is very difficult with other pigments, especially logwood, and the second is that preparations containing picric acid are little or not at all affected. Benzo-purpurin seems to be most suitable for double staining with hæmatoxylin or benzoazurin.

Hæmatoxylin Staining.†—Dr. S. Apáthy advises serial sections to be stained with a solution of 1 part hæmatoxylin crystals dissolved in 100 parts 70 per cent. spirit. They are then to be transferred to 70 per cent. spirit, to which a few drops of a 5 per cent. aqueous solution of bichromate of potash have been added. The hæmatoxylin solution is allowed to act for 10 minutes; the sections are then mopped up with blotting-paper and placed in the bichromate spirit in the dark for five to ten minutes, when they assume a bluish tinge, the celloidin remaining unstained. A double stain for differentiating the nervous and connective

* Deutsche Zeitschr. f. Thiermed. u. Vergleich. Pathol., xiv. (1889) pp. 420–2.
† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 170–1.

tissues of the Hirudinea is also given by the author. The object is placed for half an hour in a half per cent. watery solution of hæmatoxylin, then having been quickly washed in distilled water, it is transferred for two hours to a 1 per cent. aqueous solution of bichromate of potash. It is then again washed and imbedded in celloidin. The sections, which should show a pale yellowish staining, are after-stained in a weak aqueous alum-hæmatoxylin solution.

New Method of Hæmatoxylin Staining.*—Dr. N. Kultschitzky advocates the following procedure as being more simple than Weigert's method for staining nervous tissue. Pieces of brain or cord are hardened in Müller's or Erlitzki's fluid, and imbedded in celloidin. The sections are then placed in the following hæmatoxylin solution:—1 grm. of hæmatoxylin dissolved in a little alcohol is added to a mixture of 20 ccm. saturated watery solution of boracic acid and 20 ccm. distilled water. Before using this solution a little acetic acid is added (two or three drops to a watch-glassful). The sections require some few hours (to 24) for staining. The medullated nerve-fibres are stained blue, the rest of the tissue yellow, or yellowish-red. If the sections are then placed for twenty-four hours in a saturated watery solution of carbonate of soda or lithium the nerve-fibres become dark blue, while all the rest is almost uncoloured. Then alcohol, mount in balsam.

A still more simple hæmatoxylin solution, which gives the same results, is 100 ccm. of 2 per cent acetic acid, and 1 grm. of hæmatoxylin dissolved in a little alcohol.

Simplification of Weigert's Method.†—Dr. U. Rossi, who says that Weigert's method is unnecessarily complicated, recommends the following simplified procedure:—Pieces of spinal cord or brain are fixed at the ordinary temperature, or in a thermostat at 35°, in the following solution: —distilled water 100 ccm., chromic acid 0·75–1 gramme, acetate of copper 5 grammes. The time required for hardening the human cord is six to eight days; cord of dog, three to four days; for the entire brain of the dog fifteen to eighteen days, and so on according to the size of the pieces. In the thermostat the fixing process is completed in half the time required for doing the same thing at the ordinary temperature. The pieces are next transferred to rectified spirit 24 to 48 hours, and afterwards to absolute alcohol. When properly hardened they are imbedded in celloidin and sectioned. The sections are placed for staining in a vessel containing about 30 ccm. of rectified spirit, to which has been added 7 or 8 drops of a hæmatoxylin solution made as follows:— absolute alcohol 20 ccm., hæmatoxylin 1 gramme. In less than 2 or 3 hours the sections become dark, and they are then placed in some of the following solution:—absolute alcohol 100 ccm., hydrochloric acid 8 drops. Herein they assume a brick-red hue, and when the grey and white matters become differentiated they are removed to distilled water, wherein they quickly become blue. After this they are to be well washed again to remove all traces of acid, then dehydrated, cleared up, and mounted in balsam.

In addition to the foregoing stain, the author says a double stain

* Anat. Anzeig., iv. (1889) pp. 223–4.
† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 182–4.

with a weak solution of Grenacher's borax-carmine adds to the effect. The use of xylol is to be avoided, as the stains are thereby weakened.

Staining Animal Mucus with Anilin Dyes.*—Various mucoid secretions, such as saliva, synovia, &c., have been examined by Dr. Sussdorf in order to show that basic anilin dyes have a specific staining action, both on free mucus and while it is still in the secreting tissue.

As may be supposed, there seems to have been no difficulty in staining free mucus by the simple method of dropping the staining solution in the secretion, and then looking at it under the Microscope.

For showing the existence of mucus within the cells of tissues and organs, the author used sublingual, submaxillary, and parotid glands of the horse, and also the intestinal and tracheal mucosa of the horse and cat. These were well hardened in alcohol, osmic acid, and chrom-osmic acid. The sections were stained with methyl-violet, methylen-blue, or fuchsin in one per cent. solution for a few minutes only. They were then washed in alcohol or spirit acidulated with one per cent. hydrochloric acid until the dye was no longer given off. Some of the sections were also stained with borax-carmine. In the latter the nuclear and plasma-elements of the cells were stained by the carmine, while the mucinous parts were dyed by the anilin pigment. In the single-stained preparations the mucinous parts alone were coloured. Some more experiments on salivary glands by the method of double-staining seemed to the author to support Haidenhain's division of the salivary glands into serous and mucous.

Use of Colouring Matters for the Histological and Physiological Examination of Living Infusoria.†—M. A. Certes says that anilin black dissolved according to circumstances in sea or fresh water possesses striking advantages for the study of living organisms. After filtration the solution, though loaded with pigment, will keep quite a long time without forming a precipitate even on evaporation. The effect produced resembles that obtained by Nachet's dark-ground illumination method, with the special advantage that high powers and homogeneous-immersion objectives can be used.

Anilin-black is in no way toxic to Infusoria, for they will live therein and multiply for weeks together. The contractile vesicle and other anatomical details as observed by this method are particularly interesting.

Staining Actinomycosis bovis.‡—Dr. A. Florman states that he has made very successful preparations of Actinomyces by the following method which, though complicated, shows the club-shaped elements as well as the filaments. The sections used were 0·008 mm. thick. These were stained for 5 minutes in a solution of saturated alcoholic solution of methyl-violet 1 part, water 2 parts, aqueous (one per cent.) solution of carbonate of ammonia 2 parts. They were then washed for 10 minutes in water, and after this placed for 3 minutes in the iodine solution, iodine 1 part, iodide of potassium 2 parts, water 300 parts. After being carefully washed they were decolorized for 20 minutes in

* Deutsche Zeitschr. f. Thiermed. u. Vergleich. Pathol., xiv. (1889) pp. 345–59 (3 figs.).

† Bull. Soc. Zool. France, xiii. (1888) pp. 230–1.

‡ Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 190–1.

fluorescin-alcohol (i. e. until no more dye was given off). The fluorescin was washed out in 95 per cent. alcohol. Then anilin oil for some minutes. The anilin oil was removed with oil of lavender, then xylol, and finally balsam.

Decoloration of Osmized Fat by Turpentine and other Substances.*—Dr. W. Flemming gives the results of experiments on fat stained with osmic acid, and afterwards acted on by various substances. Turpentine decolorizes in $1\frac{3}{4}$ hours, ether in 4 hours, xylol in $5\frac{1}{2}$ hours. Canada balsam dissolved in turpentine and thinned with xylol in $4\frac{1}{2}$ hours, dammar dissolved in turpentine and chloroform in 3 hours; balsam dissolved in xylol, no action observed; chloroform, no action; oil of cloves, no action.

Hence xylol is much to be preferred to turpentine. But chloroform and oil of cloves are obviously safer.

(5) Mounting, including Slides, Preservative Fluids, &c.

Manipulation of Paraffin-imbedded Sections.†—Prof. H. Strasser, who keeps on devising alterations in the technique of paraffin imbedding, describes a new procedure, the chief feature of which is the manipulation of the section on a "provisional" or temporary slide.

The provisional slide is thin well-sized paper, one side of which has been smeared with a gum solution containing 10 per cent. by volume of glycerin. The section is then stuck on with a solution of collodium simplex 2, castor oil 1—and then fixed down by brushing over the upper surface with collodium conc. dupl. 2–3, castor oil 2.

The preparation is then removed to turpentine to dissolve out the oil and the paraffin, and also set the collodion. The plate, i. e. the imbedded section plus the paper, is then placed in an aqueous or watery-spirituous fluid for staining or other purposes. During the water stage the gum is dissolved, and the section in its collodion case thereby set free. The next step is to put this into turpentine again, after which it may be mounted in a resinous medium on a temporary or permanent slide.

Owing to the fact that the paper, i. e. the provisional slide, which plays the principal part in this procedure, becomes dyed in its transit through the staining solutions, the method, as the author confesses, is at present somewhat imperfect.

New Method for Fixing Sections.‡—Dr. W. M. Gray who describes the following method, says that it is identical in its procedure with the "gum arabic process," provided the tissue from which the sections are cut has been successfully stained in mass. "The process is as follows. Dissolve one part of gold label gelatin in one hundred parts of warm distilled water; after the gelatin has dissolved, filter and add a crystal of thymol, to prevent the formation of fungi. If, on standing, the gelatin coagulates, warm slightly and use the fixative in the same manner as the gum arabic solution, or in other words, flow a small quantity on the perfectly clean slide, place the object on the fluid, and heat gently until the sections or series of sections are flat and free from

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 178–81. † T. c., pp. 150–63.
‡ The Microscope, ix. (1889) pp. 325–6.

wrinkles, taking special care not to melt the paraffin surrounding the preparations. As they are perfectly flat, drain off the superabundant fluid, and stand the slide on end to dry. The best results are obtained if the slide is allowed to stand over-night to dry spontaneously. After the sections are dry, the whole is immersed in turpentine or other solvent to remove the paraffin, then into alcohol to remove the turpentine, thence into a two per cent. solution of potassium bichromate for five minutes, which renders the gelatin fixative *insoluble.* After washing the slide in water to free the section from bichromate) which, by the way, will not injure the most delicate tissue or interfere with any staining process) the section may be stained as desired. For sections stained in mass the soaking in bichromate is unnecessary, but if, after mounting, the stain should prove insufficient, the sections may be readily restained by removing the cover-glass, soaking off the balsam with a suitable solvent, transferring to alcohol and then rendering the fixative insoluble by soaking in bichromate before immersing in the stain. This process is especially valuable in staining tissues for bacteria, as it admits of extremely thin sections being placed on the slide free from wrinkles, and does not blister by prolonged soaking in aqueous solutions, as frequently happens in Schällibaum's clove-oil-collodion process, the method in general use for staining sections on the slide."

Use of Oil of Cloves.*—Mr. W. Hatchett Jackson points out that sections to which oil of cloves has been added and which have turned milky are not, as is often supposed, useless. If a small quantity of oil is poured on the sections and the whole gently warmed for a short time, the milkiness disappears. If it does not disappear at once the oil in the slide should be poured off, fresh oil added, and the heating repeated. The milkiness is due to a combination between the essential oil and a small residuum of water, and this is readily soluble by the aid of warmth in an excess of the essential oil. Repeated soaking in absolute alcohol effects the same end.

Cement for fixing down Glycerin Preparations.†—The cement recommended by Dr. S. Apáthy is said to be hard, without brittleness, and not to run under the cover-glass.

It is made of equal parts of hard paraffin, melting-point 60° C., and commercial Canada balsam. The mixture is heated in a porcelain dish until it assumes a gold yellow hue, and a resinous odour is no longer perceived. When cold the mixture forms a hard mass, which requires to be heated for use and to be laid on with a glass rod or brass spatula. The metal spatula is then heated and run round the edge to finish it off.

(6) Miscellaneous.

Detection of Blood-stains.‡—Dr. C. Charles remarks that, according to Linassier, the most sensitive spectroscopic reaction of blood is that given by reduced hæmatin.

The blood-stain is dissolved in water and examined for the spectrum

* Zool. Anzeig., xii. (1889) pp. 630–1.
† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 171–2.
‡ Amer. Mon. Micr. Journ., x. (1889) p. 236, from 'The Dosimetric Medical Review,' July 1889.

of oxyhæmoglobin. A drop of freshly prepared hyposulphite of soda is now added, when the spectrum of hæmoglobin appears at once; finally, a couple of drops of a concentrated solution of soda are added, which decomposes the hæmoglobin into globulin and reduced hæmatin, the spectrum of the latter consisting of two absorption-bands situated between D and *b*, the left one lying between D and E and being well marked; indeed, this intense band is the only one to be distinctly observed in dilute solutions, and it ought to disappear if the solution is heated to 50° C. without stirring, or agitation, and reappear on cooling; it ought further to disappear when shaken in the air, and reappear on the addition of a drop of hyposulphite of soda. This test applies even to putrid blood. Should the blood-stain have become insoluble in water, we are directed to dissolve in ammonia and reduce by adding one or two drops of a solution of ferrous sulphate and tartaric acid.

Jaksch's 'Clinical Diagnosis of Disease by Bacteriological, Chemical, and Microscopical Examination.'*—The fact that within two years Dr. R. von Jaksch's book on the diagnosis of disease has gone through two editions, and that translations into several languages are in preparation, shows that it supplies a want.

While this second edition is an improvement on the first, and is not a mere reprint thereof, yet there are several small points which are either errors of omission or commission. For example, there is no mention of Fraenkel and Netter's researches on the diagnosis and prognosis from a bacteriological examination of pleuritic fluid. On the other side, the Finkler-Prior bacillus seems to be regarded by the author as the bacillus of Cholera nostras.

These and similar deficiences apart, the work may be considered very useful, and fairly up to date.

Israel's 'Pathological Histology.'†—Dr. O. Israel's introduction to pathological histology seems to be biassed by his views on the staining of microscopical preparations, which he scornfully designates coloured mummies. In other respects the work does not seem to differ materially from the usual run of text-books on this subject, and it is well got up.

Insects in Drugs.‡—At a meeting of the Chemists' Assistants Association some rather disquieting specimens were lately exhibited, demonstrating the existence of "insects and germs" in sundry pharmaceutical preparations and drugs. The first was a fair-looking sample of crushed linseed recently obtained from a large wholesale firm, and kept in a wooden cask with a wooden cover. The exhibitor gravely asked what would be the effect of applying a poultice containing "thousands of insects" to an open wound, especially if the poultice be made with hot instead of boiling water. The other specimens, from aconite root, nux vomica, and cantharides, are perhaps of less importance, as these substances are not employed in the crude state. In the present anxiety to detect microscopic germs and to render them innocuous, it is worth considering whether we are not in danger of overlooking more obvious sources of infection. In the hunt for small deer a different lens is employed, and mental vision is thrown out of focus for larger game.

* 2nd ed. enlarged, Vienna and Leipzig, 1889, 8vo, 438 pp.
† Berlin (A. Hirschwald), 1889.
‡ Lancet, 1889 (ii.).

Brownian Movement.—The President of the New York Microscopical Society informed * the members at a recent meeting that the specimen of gamboge rubbed up in water which he had prepared on Aug. 3rd, 1874, and which had until recently showed very active movements, seemed at last to have ceased its activity, a leak having developed in the inclosing cell, and evaporation having ensued in consequence. He thought the subject of interest, as fourteen years was probably the longest period during which the phenomenon had been under observation.

We recently purchased a number of the 'Philosophical Magazine and Annals of Philosophy' for 1828, which contained (pp. 161–73) the original article of Robert Brown on the existence of active molecules in organic and inorganic bodies, and at the beginning of the article was inserted a MS. letter addressed to "Revd. Dr. Buckland, Christ Church, Oxford," and signed "J. H. C.," which, we understand from a relative of the late Dr. Buckland, to be the initials of the Rev. John Henry Conybeare, Anglo-Saxon Professor at Oxford, brother of the Dean of Llandaff.

Of Brown's views he writes as follows:—

"Touching Brown's theory that all matter consists of live mites, I don't believe a word on't. I don't wish to regard our own planet as rotten cheese any more than the moon as cream cheese. If you suspend particles of matter in a fluid for microscopical observation, a thousand circumstances, may generate motion, and to this I attribute his facts; if, however, they should be confirmed, I know nothing inconsistent with the received philosophical notions as to the intimate corpuscular structure of bodies in them. Biot, if I remember, in the optics of his Nat. Phil., has some curious speculations on the subject. He states it to be possible that solid bodies may be composed of systems of moving molecules, representing in small what the planetary systems do in large. I would only add one supposition more; that these molecules are inhabited, and have philosophers among their population who, having observed the motions of some half-dozen molecules in their neighbourhood and ascertained their laws, believe they have developed the system of the universe."

Method for Transmitting Microscopic Objects.†—Prof. G. O. Sars describes the following method for transmitting microscopic creatures from a distance:—

On March 14 a quantity of mud was gathered from a freshwater lake in the northern part of Australia. This was dried and sent to Christiania, where it was received on the 29th of October, in masses so hard and stony that they were broken with difficulty. The weather was so cold that the experiments were not begun until the last of May, the mud and its contents having been in a dried condition for more than a year. It was finally placed in an aquarium consisting of a large cylindrical glass vessel, where a great number of the various orders of the Entomostraca were hatched out from the "winter eggs" dormant in the gathering, and in many cases studied through several generations. The method is a suggestive one, and in the hands of others may be followed with as successful results.

* Journ. New York Micr. Soc., v. (1889) p. 46.

† Fordhandlinger i Videnskabs-Selskabet i Christiania, 1887. Cf. The Microscope, ix. (1889) p. 349.

Microscopical Examination of Paper.*—Mr. Herzberg, who has charge of the examinations of paper at Charlottenburg, has just published a very exhaustive work upon the subject, with numerous reproductions of microscopic preparations. He brings specially into prominence the peculiarities of certain fibres for rendering them easily distinguished.

The author uses a solution of iodine for recognizing the various fibres, which, according to their origin, assume various colours: (1) Wood-wool and jute are coloured yellow; (2) straw, "cellulose," and alfa do not change; (3) cotton, flax, and hemp are coloured brown.

For disintegrating the paper, Mr. Herzberg does not employ the processes in common use. Mechanical appliances, either needles or a mortar, do not remove the size, starch, and weighing substances which in part conceal the structure of the fibres and render the examination of them difficult. He recommends that a small quantity of the paper to be examined be submitted to ebullition for a quarter of an hour in a 1 to 2 per cent. solution of soda. In this way the foreign substances are got rid of and the fibres set free. The presence of wood-wool will be ascertained, during the boiling, by the paper becoming yellow.

After this treatment the whole is poured upon a brass strainer with fine meshes, and is washed with pure water. The washed residuum is reduced to a homogeneous paste in a porcelain mortar.

In the case of coloured paper the colouring matter must be removed if the boiling does not effect the removal. To this end, hydrochloric acid, chloride of lime, &c., is used according to the chemical nature of the colouring matter. When the paper is not sized, nothing but water is used for the boiling. If the presence of wool in the paper is suspected an alcoholic solution, instead of an alkaline one, is used, as the latter would dissolve the wool. The solution of iodine in iodide of potassium may be more or less concentrated. The colour produced varies in depth according to the concentration. The author generally uses the following formula:—Iodine, 18 grains; iodide of potassium, 30 grains; water, 5 drachms.

For spreading the paste upon the object-holder of the Microscope he employs two platinum needles. The object-holder is placed upon a white ground, so that the fibres will stand in relief more prominently. The paste is covered with a glass, and the excess of water is removed with blotting-paper. For the determination of the fibres a magnifying power of 300 diameters is best adapted, but for ascertaining the relative proportion of the fibres, one of 120 diameters, that permits of taking in a wider surface, is preferable.

* Amer. Mon. Micr. Journ., x. (1889) pp. 274–5, from 'Guttenberg Journal.'

PROCEEDINGS OF THE SOCIETY.

Meeting of 11th December, 1889, at King's College, Strand, W.C., the Rev. Dr. Dallinger, F.R.S., Vice-President, in the Chair.

The Minutes of the meeting of 13th November last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Slides (24) of Botanical Sections	*Mr. H. P. Aylward.*
Slides (2) of Diatoms from Isle of Skye	*Mr. W. Godden.*

Mr. E. M. Nelson read a paper descriptive of a new "semi-apochromatic" objective which he exhibited (*supra*, p. 92).

The Chairman said they were much obliged to Mr. Nelson for his paper, which was a thoroughly practical one. The introduction of such lenses as the one described was a matter of some moment to our English makers, and made it somewhat necessary for them to look to their laurels, because it was not only in a matter of cheapness that they were called upon to compete, but in cheapness combined with perfection. In some of those objectives which he had lately had an opportunity of examining the cheapness had been combined with what certainly was a very close approximation to perfection. In the case of one objective by Herr Schott, and also of two by Leitz, they were found to be so good that the price was perfectly marvellous.

Mr. C. Rousselet exhibited a small tank for Rotifers, &c., with a lens attached, which could be readily moved about in such a way as to render an examination of the contents very easy, so that any desired specimens could be easily picked out. The collection which the tank contained also showed that Rotifers could be readily obtained in winter. The lens used was Zeiss's No. 6 "Steinheil" (*supra*, p. 90).

The Chairman called the attention of the Fellows to this exhibit, which he thought would prove very useful to those who were collectors of Rotifera and other so-called "microscopic" aquatic animals.

Mr. Crisp called the attention of the meeting to a number of stereoscopic photomicrographs of human embryos which were shown at their recent soirée by Prof. Fol. They were of great interest, and would repay careful examination. In addition to their value from an embryological point of view, they also afforded a conclusive answer to the question brought forward at the October meeting as to whether stereoscopic photomicrographs had been produced before that time. Mr. Crisp also showed Prof. Fol's large atlas of the human embryo.

Prof. Bell said that Prof. Fol was so well known as an embryologist that it was hardly needful to enlarge upon his work to a meeting of microscopists. There was obviously great difficulty in obtaining just the specimens wanted in the human subject, though in the case of animals they were procurable at the right time when wanted, and Prof. Fol's work in this direction was likely therefore to remain unique.

The Chairman said they were greatly indebted to Prof. Fol for having afforded them the opportunity of examining the collection of slides, which was from many points of view a most remarkable and interesting one. He was sorry that Prof. Fol when in England was not able to attend their meeting. Whilst they always acknowledged exhibits sent to them, he was sure the meeting would pass a special vote of thanks to Prof. Fol.

Mr. Crisp said that he much regretted that Prof. Fol's visit was made at a time when he was so absorbed in an important matter of business that he was entirely unable to see him. As soon as he was free he called at the Professor's hotel, but found he had left. He hoped that he had been successful in explaining to Prof. Fol how exceptional the circumstances were, so that he did not feel he had been slighted by the representatives of the Society.

Mr. Crisp said they had received notice of the formation of a Scottish Microscopical Society at Edinburgh, together with a copy of the rules and other papers. They were always glad to hear of an increase in the number of Microscopical Societies, both in the interest of science itself, and also because they generally acted indirectly as feeders to this Society (see this Journal, 1889, p. 830).

Mr. C. Haughton Gill's note on a new method of treating diatoms was read by Mr. Crisp. The note, he said, was only handed in at the conclusion of their last meeting, as otherwise it would have been read then, and would have added to the interest of the specimens exhibited by Mr. Gill at the Conversazione (see this Journal, 1889, p. 834).

Mr. Bennett said he examined the specimens with very great interest, and thought they seemed to show in a way never before demonstrated that the "markings" were really openings. He should be glad to hear whether others who were interested in the subject had also looked at them, and if so, what their impressions were.

Mr. Crisp said that the result of his examination appeared clearly to show that there were perforations in the cell-wall.

Mr. A. W. Bennett gave a *résumé* of the chief points of interest in his paper "On the Freshwater Algæ and Schizophyceæ of Hampshire and Devon" (*supra*, p. 1), which he said was in continuation of the series which he had from time to time brought before the Society. The species to which he more particularly directed attention were the result of collections made during his summer holiday in the New Forest and on Dartmoor, and he pointed out to those who might be disposed to take up this or similar studies that it was hardly possible to spend two or

three weeks in examining them without coming across some which were not only interesting but also new to science.

The Chairman said the Society were greatly obliged to Mr. Bennett for his very interesting communication, which, like the others which he had made, was both practical and useful, showing that it was possible to do very good work during holidays.

Mr. Crisp reminded the Fellows that at the last meeting mention was made of a new objective with an aperture of 1·63, the price of which was said to be 400*l*. Some doubt was expressed at the time as to whether the account was not somewhat exaggerated, but since then Mr. Mayall had communicated with Jena, and they had received several communications, which enabled them to separate the truth from fiction. These communications were from Prof. Abbe, Dr. Czapski, and Dr. Van Heurck, in English, German, and French respectively, and were read to the meeting in abstract by Mr. Crisp.

A series of photomicrographs taken by Dr. Van Heurck with an objective of N.A. 1·63 with magnifying powers of 3000, 10,000 and 15,000 diameters was exhibited in illustration of the subject.

The Chairman said the meeting was greatly indebted to Mr. Crisp for the trouble he had taken to present to them in so clear a way what it must have been difficult for any one to render into English as he had done whilst reading. They were also very glad to see the photographs which were exhibited in connection with the matter. Those who had seen Dr. Zeiss's plates in his catalogue and had carefully studied the one of *P. angulatum*, would have noticed that there were six intercostal marks shown round each "cavity." In the photograph before them these were all exaggerated, but they were not materially altered in appearance, and were apparently as real as the cavities themselves. By some these appearances have been considered as entirely "ghostly," but if they were so, he could only say that in these photographs of Dr. Van Heurck it had been possible to make them look exceedingly material. The double layers had been seen very clearly before by some of their own observers, but he did not think they had been seen so well in a photograph; the detail of the intercostal markings was also remarkable. No. 4 of the series was marked as being "focused on the hexagons," which he supposed to mean focused so as to get that appearance.

Mr. T. F. Smith said it seemed to him that one material point in the description had been left out, and that was the aperture of the substage condenser, because the truthful nature of what was seen was dependent upon that.

Mr. Crisp referred to the description, and said it was mentioned that the aperture of the condenser was 1·60 N.A.

Mr. Smith asked if it stated whether the condenser was stopped down in any way?

Mr. Crisp said the illumination used was stated to be monochromatic sunlight, "moderately oblique" with *Amphipleura*, and "strictly axial" with *Pleurosigma*.

Mr. Smith thought that if it was oblique it was calculated to give a false image.

Mr. Karop pointed out that if only central light was used it was not necessary that the whole of the series of media from objective to condenser should be homogeneous, but if oblique light was used then it was essential.

Mr. Nelson said he thought there was no doubt that these photographs were taken with oblique light, because they showed the longitudinal striæ thrown out into space. In his own observations he had thought he could see some sign that the longitudinal striæ were beginning to be resolved, but he had searched for the spectra in vain. He supposed that with the new objective they might be able to see the beginning of the blue. He thought it was quite safe to say that the pictures had been taken with a narrow pencil of light, and if so they did not offer a fair test of what the objective was able to do, because it was very well known that with a small pencil like that they could make the appearance anything they pleased.

The Chairman said he thought he should express the feeling of all who were present in saying that they were extremely glad to have had the opportunity of hearing these descriptions and of seeing the photographs to which they related, and that their hearty thanks were due to those who had enabled them so to profit.

The following Instruments, Objects, &c., were exhibited:—

Mr. H. P. Aylward:—Series of Botanical Sections.

Prof. Fol:—Stereo-photomicrographs of Human Embryos.

Mr. W. Godden:—Slides of Diatoms from the Isle of Skye.

Mr. E. M. Nelson:—Semi-apochromatic Objective in illustration of his paper.

Mr. Rousselet:—Tank for Rotifers, &c., with lens attached.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Walter H. Collins, F.C.S.; Frank Conway; Samuel Gasking, B.A.; W. K. Higley, Ph.D.; G. C. Huber, M.D.; Abraham Leigh, M.D.; and Mark L. Sykes.

Meeting of 8th January, 1890, at King's College, Strand, W.C.; the Rev. Dr. Dallinger, F.R.S. (Vice-President), in the Chair.

The Minutes of the meeting of 11th December last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
52 Photomicrographic Slides	*Mr. T. F. Smith.*
MS. Catalogue of Mr. Redmayne's Collection of Diatoms	*Mr. Burgess.*

Mr. Crisp having read the Bye-laws relating to the nomination of Officers and Council for the ensuing year, read the list of names nominated by the Council in accordance therewith. He also pointed out that as on their removal to Hanover Square they would be unable to meet on the second Wednesday of the month as heretofore, several of the bye-laws would require to be altered to suit the circumstances, and he therefore gave notice that at the Annual Meeting, to be held on 12th February next, the necessary alterations will be made. It would also be necessary, at the same time, to move the suspension of Bye-law 36, in order to admit of the re-election of Dr. Hudson as President of the Society for a third year.

Mr. J. D. Hardy having been proposed as an Auditor of the Treasurer's accounts by Mr. Dadswell, and seconded by Mr. T. Charters White; and Mr. Suffolk having been proposed by Mr. Reeves, and seconded by Mr. Ward; their names were put to the meeting by the Chairman, who declared them to be duly elected Auditors.

Mr. T. F. Smith exhibited, by means of a lime-light lantern, a series of photomicrographs of various diatoms, taken with Zeiss's apochromatic objectives and projection eye-pieces, giving powers of 1000 to 7500 diameters. At the conclusion of the exhibition, Mr. Smith presented the series of 52 slides to the Society for future use and reference.

The Chairman, in inviting remarks upon the subject, said that for his own part he was convinced that a great deal of hard work was represented by what had been put before them that evening, but he thought nevertheless that he would be wisest who refrained from coming at present to any settled conclusion on the matter, because it seemed obvious that there remained still a very great deal to be learnt. Such work, however, as that which Mr. Smith had been doing, would no doubt lead to results which would be very helpful and instructive if rightly utilized. The subject was one of great interest, but also one in which continual progress was being made, as it was in fact evident that since Mr. Smith had been at work there had been some distinct advances.

Mr. E. M. Nelson said he did not propose to say anything then about the structure of the diatoms before them, because that had been admirably explained by Mr. Smith, so far as it was to be shown by the photographs which had been exhibited; in fact, he might say that Mr. Smith had originated this kind of *Pleurosigma* structure. He had seen not only the photographs, but also the specimens from which they had been taken, and could fully bear out all that had been stated. He thoroughly believed that if anything was to be done further in this direction it must be done with large-angled cones of light and central illumination, and that oblique light for this purpose must for ever be dismissed. With regard to the intercostal points, he believed that they were entirely illusory, because they could be formed equally well in any of the larger kinds if the light was arranged so as to produce them.

Mr. Crisp said that when it was stated work of this kind should be done, not with oblique light, but with a large cone of central light, the

fact was apparently overlooked that in every so-called cone of "central light" there was a large proportion of oblique light.

Mr. Crisp also remarked that Mr. Smith, in pointing to the photographs, had said that "anyone could see that the markings were perforations, and not beads." It was, however, quite impossible for anyone to distinguish between the two, by mere inspection, so readily as Mr. Smith seemed to think was possible.

Mr. Smith said he would correct that statement at once, by saying that looking at the edge of a fracture anyone could see this; he quite believed that by looking down upon the structure one could not tell which they were.

The President said they were greatly indebted to Mr. Smith for the trouble he had taken to bring this matter before them. From his own point of view it was only by the continuous prosecution of the inquiry in this and in other ways, without any attempt at explanation, that gave promise of success, and if such demonstrations were steadily continued for some time longer they might reasonably hope for a solution. They had also to thank Mr. Smith for having given to them, in a permanent form, these records of what he had up to the present time accomplished.

Mr. T. Charters White called attention to two slides which he exhibited. One of these he had called *Echinorhyncus*, but since coming to the meeting he had referred to some authorities and had reason to think that this name was inappropriate. The object was an entozoon found in the large cockroaches which infested the sugar ships; they were quite different from the ordinary kind, and were, he believed, known as *Blatta germanica*. In dissecting some of these he found a number of white particles which looked like eggs, each of which contained an embryo. He found altogether about 14, and having mounted them he had brought them for exhibition, and should be glad if anyone would tell him what they were. The other slide contained a quantity of bacilli from a urinary deposit. It was thought that the patient from whom they were obtained was suffering from hæmaturia, and the urine was therefore carefully examined; it was found to contain albumen, but no casts from the kidney could be seen. He took some of the deposited matter, and having stained it, found it to contain bacilli in enormous numbers, as would be seen in the specimen exhibited. He thought it might be of some interest, as bearing upon the subject brought up at the last meeting by Mr. Hall.

Prof. Bell thought that the objects first mentioned by Mr. White were the cystic stage of some species of tape-worm.

Mr. Michael believed that the cockroach described by Mr. White could hardly be *Blatta germanica*, which was a small, rather than a large species, and was common in houses. It was said to be much less offensive than the ordinary species, and it was also said that, though common, the two sorts were not found in the same houses.

Dr. R. L. Maddox's Note on a small Glass-rod Illuminator was read, the note being accompanied by six photographic negatives in illustration (*supra*, p. 101).

The following Instruments, Objects, &c. were exhibited:—

Dr. Maddox:—Photomicrographs of Diatoms.

Mr. E. F. Smith:—Photomicrographic Slides of Diatoms.

Mr. T. Charters White:—(1) Cystic stage of Tape-worm; (2) Bacilli from a Urinary deposit.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. G. R. Beardmore, L.R.C.P.; Alfred Cornell; Edward Crawshaw; H. Emery, M.A.; John W. Washbourn, M.D.; Edwin Webster; and *Honorary Fellow*, Mr. John Ralfs.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1890.

TRANSACTIONS OF THE SOCIETY.

III.—*The President's Address on some Needless Difficulties in the Study of Natural History.*

By C. T. Hudson, LL.D., F.R.S.

(*Annual Meeting*, 12*th February*, 1890.)

A little while ago I read in a preface to a work on natural history that the book was "of little value to the scientific reader, but that its various anecdotes, and its minute detail of observation, would be found useful and entertaining."

What then may the "Scientific Reader" be expected to desire? He must be, in my opinion, a most unreasonable man, if he does not thankfully welcome anecdotes of the creatures he wishes to study, when those anecdotes are the result of patient and accurate observation. For it is precisely such information that is conspicuously absent from many scientific memoirs and monographs, the author generally spending his main space and strength in examining the shape and structure of his animals, and in comparing one with another, but giving the most meagre details of their lives and habits.

Which, then, is the more scientific treatment of a group of animals—that which catalogues, classifies, measures, weighs, counts, and dissects, or that which simply observes and relates? Or, to put it in another way, which is the better thing to do, to treat the animal as a dead specimen, or as a living one?

Merely to state the question is to answer it. It is the living animal that is so intensely interesting, and the main use of the indexing, classifying, measuring, and counting is to enable us to recognize it when alive, and to help us to understand its perplexing actions.

But it may be objected, that because the study of the living animal is the more interesting, it is not necessarily the more scientific; indeed, that the amount of entertainment which we may get out of the pursuit of natural history has nothing to do with the question at all; that by science we mean accurate knowledge pre-

sented in the most suitable form; that shape, structure, number, weight, comparison, are the fundamental notions with which sciences of every kind have to deal; and that scientific natural history is more properly that which takes cognizance of a creature's size, form, bodily organs, and relations to other creatures, than that which concerns itself with the animal's disposition and habits.

I can fancy that I already hear some of my audience say, "But why set up any antagonism between these two ways of studying a creature? Both are necessary to its thorough comprehension, and our text-books should contain information of both kinds; we should be told how an animal is made, where it ought to be placed among others of the same group, and also how it lives, and what are its ways."

Precisely; that is just what memoirs and text-books ought to do, but what too often they do *not.* We read much of the animal's organs; we see plates showing that its bristles have been counted, and its muscular fibres traced to the last thread; we have the structure of its tissues analysed to their very elements; we have long discussions on its title to rank with this group or that, and sometimes even disquisitions on the probable form and habits of some extremely remote, but quite hypothetical ancestor—some "archi-rotator,"—to take an instance from my own subject—who is made to degrade in this way, or to advance in that, or who is credited with one organ, or deprived of another, just as the ever-varying necessities of a desperate hypothesis require; but of the living creature itself, of the way it lives, of the craft with which it secures its prey or outwits its enemies, of the home that it constructs, of its charming confidence or its diabolical temper, of its curious courtship, its droll tricks, its games of play, its fun and spite, of its perplexing stupidity, coupled with actions of almost human sagacity, of all this—this, which is the real natural history of the animal, we too often hear little or nothing. And the reason is obvious, for in many cases the writer has no such information to give; and even when he has, he is compelled by fashion to give so much space to that which is considered to be the more scientific portion of his subject, that he has scant room for the more interesting. Neither ought we to be surprised, if a writer is "gravelled for the lack of matter" when he comes to speak of an animal's life; for the study of the lives of a large majority is a difficult one. It requires not only abundant leisure, but superabundant patience, a residence favourably situated for the pursuit, and an equally favourable condition of things at home. The student, too, must be ready to adopt the inconvenient hours of the creatures that he watches, and be indifferent to the criticisms of those that watch *him.* If his enthusiasm will not carry him, without concern, through dark nights, early mornings, vile weather, fatiguing distances, and caustic chaff, the root of the matter is not in him. Besides, he ought to have a natural aptitude for the pursuit, and know how to look for what he

wants to see; or, if he does not know, to be able to make a shrewd guess; and above all, when circumstances are not favourable, to have wit enough to invent some means of making them so. And yet when the place, the man, the animals, and the circumstances, all seem to promise a rich harvest of observations, how often it happens that some luckless accident, a snapped twig, a lost glass, a hovering kestrel, a sudden gust of wind, a roving dog, or a summer shower robs the unlucky naturalist of his due; nay, it sometimes happens that, startled by some rare sight, or lost in admiration of it, he himself lets the happy moment slip, and is obliged to be contented with a sketch from memory, when he might have had one from life.

But I have not yet got to the bottom of my budget; the heaviest trouble still remains, and that is, that the result of a day's watching will often go into a few lines, or even into a few words; and so it happens that the writer of the history, of a natural group of animals, is too frequently driven to fill up his space with minute analyses of structure, discussions on classification, disputes on the use of obscure organs, or descriptions of trifling varieties, which, exalted to the rank of species, fill his pages with wearisome repetitions: for were he, before he writes his book, to endeavour to make himself acquainted with the habits of all the creatures he describes, his own lifetime might be spent in the pursuit.

We will now take a different case, and suppose that many years have been spent in the constant and successful study of the animals themselves; and that the time has come when the naturalist may write his book, with the hope of treating, with due consideration, the most interesting portion of his subject. He is now beset with a new class of difficulties, and finds that publishers and scientific fashion alike combine to drive him into the old groove: for the former limit his space by naturally demurring to a constantly increasing number of plates, and an ever-lengthening text; while the latter insists so strongly on having a complete record of the structure and points of difference of every species, however insignificant, that it is hardly possible to do much more than give that record—a mere dry shuck, emptied of nearly all that makes natural history delightful.

And so we come round again to the point that I have already glanced at, viz. "Ought natural history to be delightful?"

Ought it to be delightful! Say, rather, ought it to exist? What title has the greater part of natural history to any existence, but that it charms us? It is true that this study may help—does help many—to worthier conceptions of the unseen, to loftier hopes, to higher praise; that it gives us broader and sounder notions of the possible relation of animals, not only to one another, but also to ourselves; that it provides us with the material for fascinating speculations on the embryology of our passions and mental powers; and that it may even serve to suggest theories of the commencement and end of things, of matter, of life, of mind, and of consciousness—grave questions,

scarcely to be dealt with successfully by human faculties, but in a condition to be discussed with infinite relish.

When I speak, then, of the pleasure we derive from the study of natural history, I include these graver and higher pleasures in the word.

Here and there, too, no doubt, the knowledge of the powers and habits of animals is materially useful to us; and, indeed, in the case of some of the minuter organisms may be of terrible importance; but in that of the large majority of creatures we might go out of the world unconscious of their existence (as indeed very many people do), and yet, unlike the little jackdaw, not be "a penny the worse." For what is a man the better for studying butterflies, unless he is delighted with their beauty, their structure, and their transformations? Why should he learn anything about wasps and ants, unless their ways give him a thrill of pleasure? What can the living plumes of the rock zoophytes do for us, but witch our eyes with their loveliness, or entrance us with the sight of their tiny fleets of medusa-buds, watery ghostlets, flitting away laden with the fate of future generations?

When, at dusk, we steal into the woods to hear the nightingale or watch the nightjar, what more do we hope for than to delight our ears with the notes of the one, or our eyes with the flight of the other? When the Microscope dazzles us with the sight of a world whose inhabitants and their doings surpass the wildest flights of nightmare or fairy tale, do we speculate on what possible service this strange creation may render us? Do we give a thought to the ponderous polysyllables that these mites bear in our upper world, or to their formal marshalling into ranks and companies which are ever being pulled to pieces, to be again rearranged? No! it is the living creature itself which chains us to the magic tube. For there we see that the dream of worlds peopled with unimagined forms of life, with entient beings whose ways are a mystery, and whose thoughts we cannot even guess at, is a reality that lies at our very feet; that the air we breathe, the dust that plagues our nostrils, the water we fear to drink, teem with forms more amazing than any with which our fancy has peopled the distant stars; and that the actions of some of the humblest arouse in us the bewildering suspicion, that even in these invisible specks there is a faint foreboding of our own dual nature.

If, then, we make some few exceptions, we are entitled to say that the study of natural history depends for its existence on the pleasure that it gives, and the curiosity that it excites and gratifies; and yet, if this be so, see how cruelly we often treat it. Round its fair domain we try to draw a triple rampart of uncouth words, elaborate yet ever-changing classifications, and exasperatingly minute subdivisions, and we place these difficulties in the path of those whose advantages are the least, those who have neither the vigorous tastes that enable them to clear such obstacles at a bound, nor the homes whose fortunate position enables them to slip round them. For modern town-life

forces a constantly increasing number of students to take their natural history from books; and too often these are either expensive volumes beyond their reach, or dismal abridgments which have shrunk, under examination pressure, till they are little less than a stony compound of the newest classification, and the oldest woodcuts. But the happier country lad wanders among fields and hedges, by moor and river, sea-washed cliff and shore, learning zoology as he learnt his native tongue, not in paradigms and rules, but from mother Nature's own lips. He knows the birds by their flight and (still rarer accomplishment) by their cries. He has never heard of the *Œdicnemus crepitans*, the *Charadrius pluvialis*, or the *Squatarola cinerea*, but he can find a plover's nest, and has seen the young brown peewits peering at him from behind their protecting clods. He has watched the cunning flycatcher leaving her obvious and yet invisible young in a hole in an old wall, while she carries off the pellets that might betray their presence; and has stood so still to see the male redstart, that a field-mouse has curled itself up on his warm foot and gone to sleep. He gathers the delicate buds of the wild rose, happily ignorant of the forty-odd names under which that luckless plant has been smothered; and if, perchance, his last birthday has been made memorable by the gift of a Microscope, before long he will be glorying in the transparent beauties of *Asplanchna*, unaware that he ought to crush his living prize, in order to find out which of some half-dozen equally barbarous names he ought to give it.

The faults, indeed, of scientific names are so glaring, and the subject is altogether so hopeless, that I will not waste either your time or my patience by dilating on it. But, while admitting that distinct creatures must have different names, and very reluctantly admitting that it seems almost impossible to alter the present fashion of giving them, I see no reason why these, as well as the technical names of parts and organs, should not be kept, as much as possible, in the background; and not suffered to bristle so in every page, that we might almost say with Job, "there are thistles growing instead of wheat, and cockle instead of barley."

We laughed at the droll parody in which the word *change* was defined as "a perichoretical synechy of pamparallagmatic and porroteroporeumatical differentiations and integrations"; yet it would not be a difficult matter to point out sentences in recent works on our favourite pursuits, that would suggest a similar travesty. No doubt new notions must often be clothed in new language, and the severer studies of embryology and development require a minute precision of statement, that leads to the invention of a multitude of new terms. Moreover, the idea that the meaning of these terms should be contained in the names themselves is excellent, but I cannot say that the result is happy; I might almost say that it is repulsive; and if we suffer this language to invade the more popular side of natural history, I fear that we shall only write for one another, and that our scientific

treatises will run the risk of being looked at only for their plates, and of being then bound up with the Russian and Hungarian memoirs.

The multiplication of species, too, is a crying evil, and the exasperating alterations of their names in consequence of changing classifications, is another. The former, of course, is mainly due to the difficulty (no doubt a very great one) of determining what shall be a species and what a variety. How widely experts may differ on this question, Darwin has shown, by pointing out that, excluding several polymorphic genera and many trifling varieties, nearly two hundred British species, which are generally considered varieties, have all been ranked by botanists as species; and that one expert has made no fewer than thirty-seven species of one set of forms, which another arranges in three. Besides, even in the cases where successive naturalists have agreed in separating certain forms, and in considering them true species, it happens now and then, as it did to myself, that a chance discovery throws down the barriers and unites half-a-dozen species into one.

Under these circumstances one would have expected that the tendency would have been to be chary of making new species; and no doubt this is the practice of the more experienced naturalists, but among the less experienced there is a bias in the opposite direction; and all of us, I fear, are liable to this bias when we have found something new; for even if it is somewhat insignificant, we are inclined to say with Touchstone, "A poor thing, sir, but mine own!" Now were this fault mended, much would be avoided that tends to make monographs both expensive and dull; for though the needs of science require a minute record of the varieties of form, which are sometimes of high importance from their bearing on scientific theories, yet the description of them, as varieties, may often be dismissed in a line or two, when nothing further is set forth than their points of difference; whereas if these forms are raised to the rank of species, they are treated with all the spaced-out dignities of titles, lists of synonyms, specific characters, &c., &c., and so take up a great deal of valuable room, weary the student with repetitions, and divert his attention from the typical forms.

But when everything has been done that seems desirable, when names and classification have been made both simple and stable, and the number of species reduced to a minimum, there will still remain the difficulty that monographs must, from the nature of the case, generally be grave as well as expensive books of reference, rather than pleasant readable books, within the reach of the majority. I would suggest then that, if it be possible, each group of animals should be described, not only by an all-embracing monograph to be kept for reference on the shelves of societies like our own, but by a book that would deal only with a moderate number of typical, or very striking forms; that would describe these fully, illustrate them liberally from life, and give an ample account of their lives and habits.

Such a book should give as little of the classification as possible, it should avoid the use of technical terms, and above all it should be written with the earnest desire of so interesting the reader in the subject, that he should fling it aside and rush off to find the animals themselves. By this means we should not only get that active army of out-of-door observers which science so greatly needs, but by bringing the account of each group into a reasonable compass, we should enable students of natural history to get a fair knowledge of many subjects, and so greatly widen their ideas and multiply their pleasures.

For why should we be content to read only one or two chapters of Nature's book? To be interested in many things—I had almost said in everything—and thus to have unfailing agreeable occupation for our leisure hours, is no bad receipt for happiness. But life is short, and its duties leave scant time for such pursuits; so that to acquire a specialist's knowledge of one subject, would often be to exchange the choice things of many subjects, for the uninteresting things of one. And how uninteresting many of these are! How is it possible for any human being to take pleasure in being able to distinguish between a dozen similar creatures, that differ from one another in some trifling matter;—that have a spike or two more or less on their backs, a varying number of undulations in the curve of their jaws, or differently set clumps of bristles on their foreheads? Why should we waste our time and our thoughts on such matters? The specialist, unfortunately, must know these things, as well as a hundred others equally painful to acquire and to retain, and no doubt he has his reward; but that reward is not the deep delight that is to be found in the varied study of the humbler animals; of those beings "whom we do but see, and as little know their state, or can describe their interests or their destiny, as we can tell of the inhabitants of the sun and moon:—creatures who are as much strangers to us, as mysterious, as if they were the fabulous, unearthly beings, more powerful than man, yet his slaves, which Eastern superstitions have invented."

Those, then, who are blest with a love of natural history, should never dull their keen appreciation of the wonders and beauties of living things, by studying minute specific differences; or by undertaking the uninteresting office of finding and recording animals, that may indeed be rare, but which differ from those already known in points, whose importance is due solely to arbitrary rules of classification.

This eagerness to find something new, errs not only in wasting time and thought on matters essentially trivial and dull, but in neglecting things of the greatest interest which are always and everywhere within reach. Take for instance the case of *Melicerta ringens.* What is more common, what more lovely than this well-known creature? And yet how much there remains to

be found out about it. No one, for example, has ever had the patience to watch the animal from its birth to its death; to find out its ordinary length of life, the time that it takes to reach its full growth, the period that elapses between its full growth and death, or, indeed, if there be such a period. And yet even these are points which are well worth the settling. For if *Melicerta* reaches its full growth any considerable time before the termination of its life, it would seem probable that, owing to the constant action of its cilia, it would either raise its tube far above the level of its head, or else be constantly engaged in the absurd performance of making its pellets and then throwing them away. Who has ever found it in such a condition, or seen it so engaged? Yet the uninterrupted action of the pellet-cup would turn out the six thousand pellets, which form the largest tube that I am acquainted with, in about eight days, and those of an average tube in less than three, while the animal will live (according to Mr. J. Hood*) nearly three months in a zoophyte trough, and no doubt much longer in its natural condition. It is true that the creature's industry, in tube-making, is not continuous. It is often shut up inside its tube, when all ciliary action ceases; and, moreover, when expanded, it may be seen at times to allow the formed pellet to drift away, instead of depositing it: but, allowing for this, there is no little difficulty in understanding how it is that, with so vigorous a piece of mechanism as the pellet-cup, the tube at all ages, except the earliest, so exactly fits the animal. I am aware that it has been stated that the whole of the cilia (including those of the pellet-cup) are under the animal's control, and that their action can be stopped, or even reversed, at pleasure. But this I think is an error. Illusory appearances, like those of a turning cog-wheel, may be produced by viewing the ciliary wreath from certain points, and under certain conditions of illumination; and these apparent motions are often reversed, or even stopped, by a slight alteration either in the position of the animal, in the direction of the light, or in the focussing of the objective. When, however, under any circumstances, the cilia themselves are distinctly seen, they are invariably found to be simply moving up and down; now lashing sharply towards the base, and now recovering their erect position. Even the undoubtedly real reversal of the revolution of the pellet in its cup, which is constantly taking place, can be easily explained by purely mechanical considerations, and consistently with the continuous up and down motion of the cilia. Moreover, of the absolute stoppage of the cilia, in the expanded rotiferon, I have never seen a single instance. In all cases, on the slightest opening of the corona, the cilia begin to quiver, and they are always in full action, even before the disc is quite expanded; while, should

* Mr. Hood, of Dundee, has kept in his troughs *Melicerta ringens* for 79 days, *Limnias ceratophylli* for 83 days, *Cephalosiphon limnias* for 89 days; the *Flosculariæ* usually lived about 50 days, but *F. Hoodii* died, before maturity, in 16 days.

a portion of the coronal disc chance to be torn away, its cilia will continue to beat for some time after its severance: so that there is good reason for believing that the ciliary action is beyond the animal's control.

It is possible, indeed, that *Melicerta* may continue to grow (as Mr. Hood says, that the Floscules appear to do) as long as it lives; or it may adopt the plan of some species of *Œcistes*, which, to prevent themselves from being hampered by their ever-growing tubes, quit their original station at the bottom of the tube, and attach themselves to it above, creeping gradually upwards as the tube lengthens. At any rate it would be interesting and instructive to watch the growth of a *Melicerta*, and the building of its tube, from the animal's birth to its death. An aquarium, in which *Melicerta* would live healthily and breed freely, could easily be contrived; and a little ingenuity would enable the observer to remove any selected individual to a zoophyte trough, and back again, without injury; and his trouble perhaps would be further repaid by such a sight, as once delighted my eyes at Clifton; where I picked from one of the tanks of the Zoological Gardens some *Vallisneria*, whose ribbon-like leaves were literally furred with the yellow-brown tubes of *Melicerta*. I coiled one of these round the wall of a deep cell, and thus brought into the field of view, at once, more than a hundred living *Melicertæ* of all ages and sizes, and all with their wheels in vigorous action —a display never to be forgotten.

Such a tank, so stocked and managed, would probably enable a patient and ingenious observer to decide several other points, about which we are at present in ignorance: to say whether the same individual always lays eggs of the same kind, or whether it may lay now female eggs, now male, now ephippial eggs; and to say what determines the kind of egg that is to be laid; whether it is the age of the individual, or the supply of food, or the temperature, or sexual intercourse that is the potent cause. It would, too, hardly be possible for the male to escape the observation of a naturalist, who possessed a tank, in which were living, hundreds of *Melicertæ;* and the male is as yet almost unknown.

Judge Bedwell found in the tubes of the female, in the winter, a small rotiferon resembling the supposed male, that I had seen playing about *M. tubularia;* only the former had a forked foot, and sharp jaws, that were at times protruded beyond the coronal disc. Its frequent occurrence in the tubes in various stages of development, and the nonchalance with which the female suffered it to nibble at her ciliary wreath, inclined the observer to conclude that the animal was the long sought-for male. Unfortunately it was only observed when in motion, so that its internal structure was not made out; and the matter therefore still rests in some doubt.

No doubt it is a strong argument, that the female would suffer nothing but a male to take such liberties with her; but it would

seem, from the following account, that it is possible for such freedoms to be pushed too far.

Mr. W. Dingwall, of Dundee, was on one occasion watching a male Floscule circling giddily round a female, and constantly annoying her by swimming into her fully expanded, coronal cup. Again and again she darted back into her tube, only to find her troublesome wooer blocking up her cup and sadly interfering with, what to a Floscule, is the very serious business of eating; for these animals will often eat more than their own bulk in a few hours. It was clear, at last, that the lady would not tolerate this persistent interference with her dinner; for when, after waiting rather a longer time than usual closed up in her tube—so as to give him every chance—she once more expanded, only to find him once more in his old position, she lost all patience, and effectually put an end to his absurdities, by giving one monstrous gulp, and swallowing her lover. It will not surprise you to hear that he did not agree with her, and that after a short time she gave up all hope of digesting her mate, and shot him out into the open again, along with the entire contents of her crop. He fell a shapeless, motionless lump; the two score and ten minutes of a male rotiferon's life cut short to five; but, strange to say, in a minute or two, first one or two cilia gave a flicker, then a dozen; then its body began to unwrinkle and to plump up; and at last the whole corona gave a gay whirl and the male shot off as vigorous as ever, but no doubt thoroughly cured of his first attachment.

I have taken *Melicerta ringens* as an example of what yet remains to be done, even with an animal which is as common in a ditch, as a fly is in a house; but almost every other rotiferon would have done equally well; for there is scarcely a single species, whose life-history has been thoroughly worked out.

To me, natural history, in many of its branches, seems to resemble a series of old, rich mines, that have been just scratched at by our remote ancestors, and then deserted. Our predecessors did their best with such feeble apparatus as they had; it was not much, perhaps, but it was wonderful that they did it all with no better appliances; and it irks me to think that we, who are equipped in a way which they could not even dream of, should turn our backs on the treasures lying at our feet, and go off prospecting in new spots, contented too often with a poor result, merely because it is from a new quarter.

Besides, the love of novelty is a force too valuable to be wasted on a mere hunt for new species in any one group of animals, especially unimportant ones. It should rather be used to make us acquainted with the more striking forms of many groups. Let us have no fear of the reproach of superficial knowledge; every one's knowledge is superficial about almost everything; and even in the case of those few who have thoroughly mastered some one subject, their knowledge of that must have been superficial for a great portion of their time. Indeed, the taunt is absurd. I can imagine that a superficial know-

ledge of law, or surgery, or navigation may bring a man into trouble; but what possible harm can it do himself, or any one else, that he is content with knowing five Rotifera instead of five hundred? And yet if any naturalist were to study only *Floscularia*, *Philodina*, *Copeus*, *Brachionus*, and *Pedalion*, it would give him the greatest possible pleasure, as well as an excellent general notion of the whole class. Let any tyro, at the sea-side, watch the ways and growth of a *Plumularia*, or of a rosy feather-star; his knowledge of the groups to which they belong could certainly not be dignified even with the term "superficial"—"linear," or "punctiform," would be more appropriate —but the pleasure, that he would derive from such a study, could not be gauged by counting the number of animals that he had examined. It would depend on the man himself; and might, I should readily imagine, far exceed that derived by the study of a hundred times the number of forms in books; especially when such a study had been undertaken, not from a natural delight in it, but from some irrelevant reason, such as to support a theory, to criticize an opponent, to earn a distinction, or to pass an examination.

In truth, that knowledge of any group of animals, which would rightly be called superficial, when contrasted with the knowledge of an expert, is often sufficient to give us a satisfactory acquaintance with the most interesting creatures in it; to make us familiar with processes of growth and reproduction too marvellous to be imagined by the wildest fancy; and to unfold to us the lives of creatures who, while possessing bodily frames so unlike our own, that we are sometimes at a loss to explain the functions of their parts, yet startle us by a display of emotions and mental glimmerings, that raise a score of disquieting questions.

Moreover, there is another excellent reason why we should not confine our attention to one subject, and that is that even the most ardent naturalist must weary at times of his special pursuit. Variety is the very salt of life; we all crave for it, and in natural history at all events we can easily gratify the craving. If we are tired of ponds and ditches, there are the rock-pools of our south-western shores, and the surface of our autumn seas. A root of oar-weed torn at random from a rocky ledge, an old whelk-shell from deep water, a rough stone from low-water mark, the rubbish of the dredge, each and all will afford us delightful amusement. It is wonderful too, what prizes lurk in humble things, and how often these fall to beginners. The very first time that I tried skimming the sea with a muslin net, I picked a piece of green seaweed off the muslin, intending to throw it away; but, seeing a little brown spot on it, I dropped the weed (not a square inch) into a bottle of sea-water instead. At once the brown speck started off and darted wildly round the bottle. It was too small to be made out with the naked eye, but by the time I had brought my lens to bear, it had vanished. I hunted all over the bottle and could see nothing; neither with the lens nor without it. I was

half inclined to throw away the water; but as I was certain that I had seen something in it two minutes before, I corked up the bottle and took it home. When I next looked at it, there was the little brown creature flying about as wildly as ever. I soon found out, now, that I had caught a very tiny cephalopod—something like an octopus, and with a pipette I fished it out and dropped it into a glass cell. At least I dropped the water from the pipette into the cell; but the animal itself had vanished again; I could not see it either in the bottle, or the cell. I was not going to be tricked again; so I pushed the cell under the Microscope, and there was my prize, motionless, but for its panting, and watching me, as it were, up the Microscope, with its big blue-green eyes. It was almost colourless, and was dotted at wide intervals with very minute black spots, set quincunx fashion—spots absolutely invisible to the sharpest unaided sight.

As I looked it began to blush—to blush faint orange, then deeper orange, then orange-brown; a patch of colour here, another there, now running across one side of the body, now fading away again to appear on a tentacle; till at last, as it recovered from its alarm, each black spot began to quiver with rapid expansions and contractions, and then to spread out in ever varying tints, till its wavering outlines had met the expansions of its neighbouring spots; and the little creature, regaining its colour and its courage at the same moment, rushed off once more in a headlong course round the cell.

I was the merest beginner when I saw this, but I had the good luck, knowing nothing whatever about it, and never having given the subject a thought, to see with my own eyes, how effectually cuttle-fishes are protected by their loss of colour, and also to see how the loss takes place.

No doubt the sea-side of our south-western coasts—I mean its creeks, not "the thundering shores of Bude and Bos"—is a paradise for microscopists; but there is no need that we should travel so far afield. Our inland woods, our lanes and pastures will yield to us a thousand beauties and wonders. The scarlet pimpernel will show its glorious stamens, the flowers of the wound-wort glow like a costly exotic; wild mignonette will rival in its fantastic shape the strangest orchid; the humblest grass will lift a tuft of glistening crystals, the birch and salad burnet shake out their crimson tassels; the Jungermanns will display their mimic volcanoes, the mosses unfold the delicate lacework of their dainty urns. But the time would fail me to name one tithe of those sources of wonder and delight that lie all around us; and most of which, as in case of the Rotifera, contain numberless points on which we are all happily ignorant, and therefore in the best of all possible conditions for deriving endless pleasure and instruction from them. Besides, my time and your patience must, I think, be drawing to a close; I would then only once more suggest that we should not only explore for ourselves all these "pastures new"—no matter how imperfectly—but that we should encourage those, who can be our most

efficient guides, to indulge us with the main results, in the simplest language. Surely one of the most charming subjects that can interest human beings, admits of being so treated; and there can be no good reason why the Muse of Natural History (for no doubt there is such a Muse) should resemble that curious nymph among the *Oribatidæ*, whom Mr. Michael found lying under the moss of an old tree, half smothered in a heap of her cast-off skins, admirable types of successive classifications and abandoned nomenclature.

Happily, however, books in such matters are of little importance; and names and classifications of still less: both these latter, indeed, are of ephemeral interest; they are the pride of to-day and the reproach of to-morrow. It is to the living animals themselves that we must turn, fascinated not only with their beauty and their actions, but with the questions which the contemplation of them perpetually provokes, and very rarely answers.

For, in the long procession of the humbler creatures, who can tell where life first developes into consciousness, and why it does so; where consciousness first stretches beyond the present so as to include the past, and why that happens; or at what point, and why, memory and consciousness themselves are lighted up by the first faint flashes of reason?

We know nothing now of such matters, and probably we never shall know much; but the mere fact, that the study of natural history irresistibly draws us to the consideration of these questions, gives to her pleasant features an undoubted dignity, and raises the charming companion of our leisure hours to the rank of an intimate sharer of some of our gravest thoughts.

IV.—*On the Variations of the Female Reproductive Organs, especially the Vestibule, in different species of Uropoda.*

By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S., &c.

(*Read* 19*th March*, 1890.)

Plate IV.

In January 1889 I read, before this Society, a paper upon the internal anatomy of *Uropoda Krameri*.* In that paper I described, *inter alia*, the female reproductive system, which on the whole agreed fairly well with that of the *Oribatidæ;* but in which the long ovipositor

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EXPLANATION OF PLATE IV.

ov, ovary. *od*, oviducts. *e*, egg. *va*, vagina. *n*, neck of same. n^1, terminal part gathered round the heel of the perigynum. *pg*, perigynum. *ves*, folded and flexible membrane attached round the edge of the perigynum above, and round the edge of the genital aperture below; this membrane and the perigynum form the walls of the "vestibule." *gp*, genital plate (epigynum). gp^1, thin projecting portion at the anterior end of same. ch^1, chitinous strengthening-pieces along the lateral edge of the perigynum. *rs*, receptaculum seminis. *ag*, accessory glands. m^1, occlusor muscles of genital plate. t^1, tendinous attachment of same. m^2, levator muscles of the perigynum. m^3, depressor muscles of the lower edge of the neck of the vagina. t^3, tendinous attachment of same. *vp*, portions of the chitinous ventral plate.

Lettering applicable only to the figures of *Uropoda ovalis.*—m^4, retractor muscles of receptaculum seminis. *f*, fold of *ves*. *fr*, fringe round edge of perigynum on the ventral side. ch^2, chitinous strengthening-piece round the heel of the perigynum. *co*, collar of clear chitin attached to same. a^2, chitinous strengthening-piece partly round the edge of the receptaculum seminis. *gm*, membranous spatulate piece lying within the hollow of the genital plate.

Lettering applicable only to figures of *Uropoda vegetans.*—*si*, sigmoid piece.

Fig. 1.—*Uropoda ovalis* Koch ♀. Whole genital system seen from the dorsal surface (above), × 65.
" 2.—Ditto. Anterior portion of same, side view, × 100.
" 3.—Ditto. Perigynum and surrounding parts, and neck of the vagina, seen from the dorsal surface (above), × 150.
" 4.—Ditto. Perigynum and portion of the other parts of the vestibule seen from the ventral surface (below), × 150.
" 5.—Ditto. Side view of the perigynum, vagina. &c.; the accessory glands, fringe, and membranous portion of the vestibule have been removed in order to show the attachment of the muscle and tendon m^3 t^3 to the lower edge of the neck of the vagina, which is drawn backward, × 150.
" 6.—Ditto. Opening of the neck of the vagina, seen from the anterior end of the creature, showing the insertion of the heel of the perigynum into the opening, × 200.
" 7.—Ditto. Perigynum detached; three-quarter view to show the shape, × 100.
" 8.—Ditto. Receptaculum seminis from below, × 150.
" 9.—Ditto. Genital plate (epigynum), × 60.
" 10.—Ditto. Thin projecting end of same, × 150.
" 11.—Ditto. Sagittal section, nearly median, × 60. *mo*, mouth-aperture. *œ*, œsophagus. *v*, ventriculus. *c*, colon. *r*, rectum (cloacal). *a*, anus. *mg*, portions of the Malpighian vessels (cut through by the section). *dp*, dorsal chitinous plate with lining membrane. *ep*, epistome joined to dorsal plate by a median chitinous lamina. *ot*, chitinous walls of the oral

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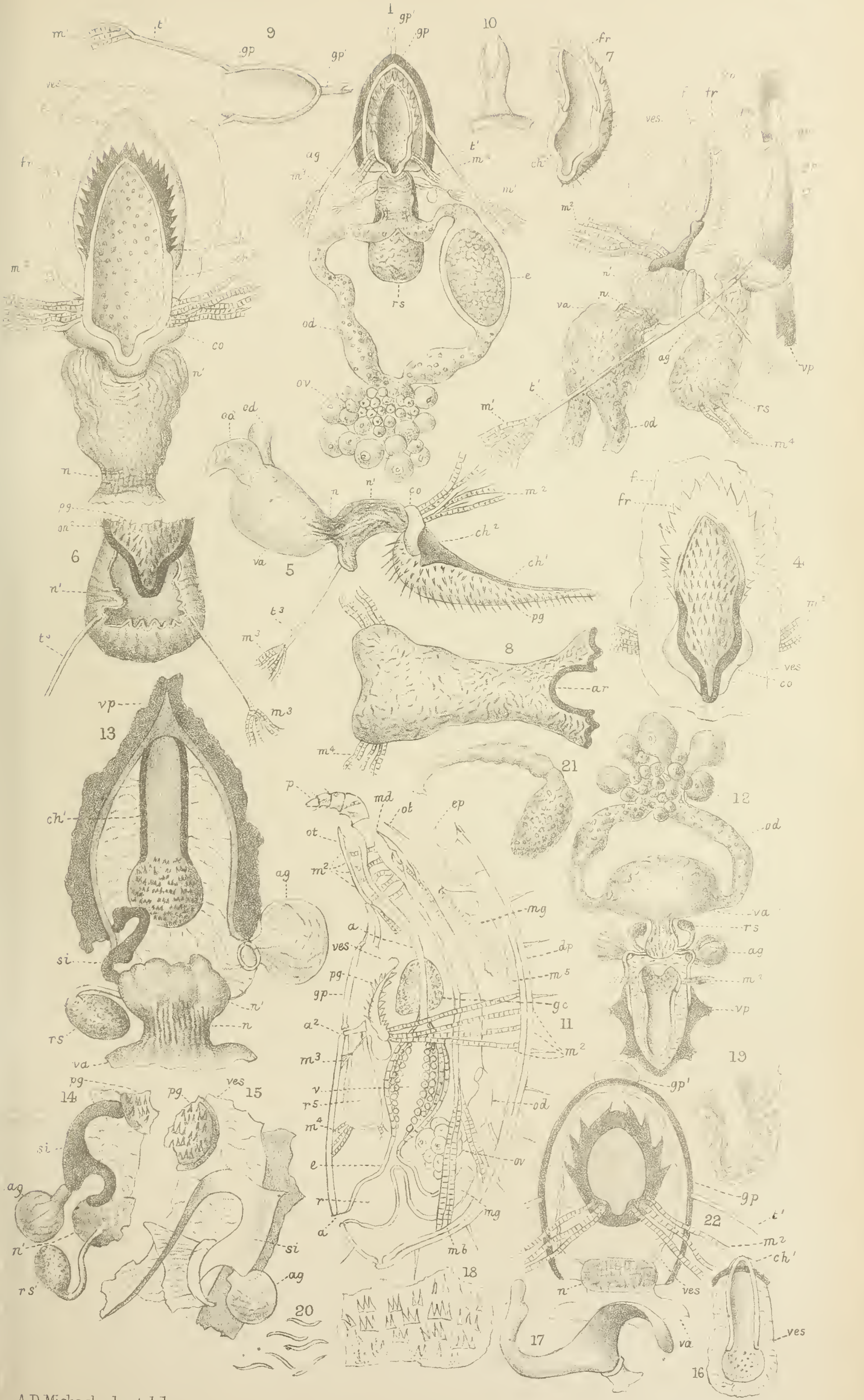
* This Journal, 1889, pp. 1–15.



A.D. Michael ad nat del.

West, Newman lith.

Anatomy of Uropoda

of the last-named family was entirely absent, being to some extent replaced by the curious and elaborate organ which I called the "vestibule"; there was, however, this essential difference, viz. that the ovipositor of the *Oribatidæ* is a long, protrusible organ, which, when in action, is almost wholly outside the body, like the ovipositors of Insects, although it is withdrawn into the abdomen at ordinary times; while the vestibule of the *Uropodinæ* is merely a passage leading from the vagina to the exterior; and is, at all times, wholly within the body and entirely incapable of protrusion; it is, however, not a simple chamber, but is of an elaborate nature, and has more or less complex organs surrounding it.

In the autumn of 1889 I had opportunities of obtaining some species of *Uropoda* in considerable numbers, and I thought this would be a favourable opportunity for ascertaining whether the vestibule in the females of other species of the genus were similar to that of *U. Krameri.* On investigation I found that, although the ovary, oviducts, and vagina varied but little, yet that the vestibule and surrounding organs did not really agree in any two species; the differences were often very marked, the type of *U. Krameri* not being repeated anywhere. It is a few of the more remarkable of these variations which I propose to describe in this paper.

The two principal species which I have examined have been those which I call *U. ovalis* Koch, and *U. vegetans* de Geer. In

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tube. m^5, retractor muscles of the same. *md*, mandibles. m^6, retractor muscles of same. *p*, palpus. *ge*, great œsophageal ganglion (so-called brain). m^7, distensor muscles of œsophagus.

Fig. 12.—*Uropoda vegetans* ♀. Whole genital system seen from the dorsal (upper) surface, × 80. This figure is turned in the reverse direction from the others.

„ 13.—Ditto. Vestibule and surrounding parts, seen from the ventral surface, looking upward through the genital aperture, the genital plate having been removed. In order to make this figure clearer the receptaculum seminis and sigmoid piece have been removed from the right-hand side of the figure (proper left of the creature), and the accessory gland from the left-hand side (proper right of the creature). *df*, depressed marginal border of thin chitin forming a stop for the genital plate, against which it rests.

„ 14.—Ditto. A small portion of the left side of the same organs seen from the dorsal surface, to show the entry of the duct of the receptaculum seminis into the upper part of the neck of the vagina, × 160.

„ 15.—Ditto. Left sigmoid piece and some of the surrounding organs, partly side view, from below, × 160.

„ 16.—Ditto. Epigynum, &c., seen from dorsal surface, × 100.

„ 17.—Ditto. Sigmoid piece detached and seen from a nearly dorsal direction, × 200.

„ 18.—Ditto. A small portion of the heel of the perigynum, × 350, to show the nature of the spines.

„ 19.—Ditto. Thin chitinous piece supporting the membranous continuation of the lower edge of the vagina, × 180.

„ 20.—Ditto. A few spermatozoa released from the receptaculum seminis, × 200.

„ 21.—Ditto. One receptaculum seminis and duct detached.

„ 22. *Uropoda cassidea* ♀. Perigynum and surrounding organs, seen from the upper (dorsal) side, × 160.

studying the former of these I have had the assistance of Mr. M. J. Michael, who has also cut some excellent sections, from one of which fig. 11, plate IV., is drawn.

I say above, "which I call *U. ovalis* Koch and *U. vegetans* de Geer." I use that expression because there has been, and still exists, great confusion about the synonymy of these two species; and although this is entirely an anatomical paper, it seems necessary to enter into the question in order that biologists may be able to identify the creatures I am talking about. *U. ovalis* is a name first used by C. L. Koch.* He calls it *Notaspis ovalis*, following an error of Hermann's,† who mistook his species of the genus *Uropoda*, viz. *U. cassidea*, for one of the *Oribatidæ*. Koch, in the same work,‡ describes another species, which he calls "*obscurus*." The most striking differences are, that *ovalis* is almost pointed at the hinder end, and is stated to be one of the largest species; *obscurus* is rounded at the hinder end, "mit regelmässig gerundetem Hinterrande," and it is not stated to be large. Julius Muller was the next who used the name.§

In 1876 Mégnin‖ described a species which he called *Uropoda scutata;* he did not figure it, and I do not see how it is possible to identify anything from his extremely short description; nevertheless Haller,¶ in 1881, described and figured what he called the *U. scutata* of Mégnin. Haller's figure was certainly drawn from the creature which I have been dissecting, and which I believe to be the *U. ovalis* of Koch.

In 1876 Kramer** described as *U. ovalis* a species with a rounded posterior margin, which does not appear to me to agree with Koch's figure or description; but which, as will be seen below, I think may probably be identical with what must be considered to be *U. vegetans* of de Geer.

In 1877 Canestrini and Fanzago†† simply followed Kramer.

In 1881 Berlese‡‡ described the species with the nearly pointed posterior margin which I have been dissecting, and in 1884 he published a good figure of it.§§ In both of these works he calls it *Uropoda* (or *Notaspis*) *obscura* Koch, which in my opinion is an

* 'Deutschlands Crustaceen, Miriapoden und Arachniden,' Regensburg, 1835–41, Heft xvii. fig. 21.

† 'Mémoire Aptérologique,' Strasbourg, 1804.

‡ Heft ii. fig. 5.

§ "Insecten Epizoen der Mährischen Fauna," Jahresheft der Naturwiss. Sektion der Mähr-Schles. Ges., 1859, pp. 157–84.

‖ "Mém. sur l'Organisation, &c., des Acariens de la famille des Gamasides." Journ. de l'Anat, et de la Physiol. (Robin's), May 1876.

¶ "Acarinologisches." Archiv für Naturges., 1881, p. 185.

** "Zur Naturg. einiger Gattungen aus d. Familie d. Gamasiden." Archiv für Naturges., 1876, p. 78.

†† "Intorno agli Acari Italiani." Atti d. R. Ist. Ven. d. Sci. Let. ed Arti, 1877, p. 59.

‡‡ "Indagini sulle metamorfosi di alcuni Acari insetticoli." Op. cit., 1881.

§§ 'Acari Miriapodi e Scorpioni Italiani," fasc. xi. pl. viii., Padua, 1884.

error. He also identifies it with *Notaspis marginatus* and *N. immarginatus* of Koch ; this, I think, is also a mistake ; but he identifies it with *Uropoda scutata* Mégnin-Haller, which is correct, and also with Kramer's species of the same name, which is more doubtful. In his last-named work * he describes a different species as *ovalis*.

In 1885 Canestrini † follows Berlese.

The result of all this is that the synonymy is as follows :—

The species with the abdomen nearly pointed posteriorly, and which I refer to, is

Uropoda ovalis of Koch, but not of Kramer, Canestrini, nor Berlese.

Uropoda scutata of Mégnin and Haller, but probably not of Kramer.

Uropoda obscura of Berlese and Canestrini, but not of Koch.

The best published drawing of the species is that by Berlese in his 'Acari &c. Ital.'

This species is probably the one treated of by Winkler in his 'Anatomie der Gamasiden';‡ he calls it "*Uropoda obscura* Koch ?" If, as is probable, he identified his species from Berlese's drawing, the ? may well have been introduced on comparing it with Koch's original drawing and description; his paper is strictly anatomical, and I imagine that we have been dissecting the same species from the agreement of his description of the alimentary canal and other internal parts with what I found, although they differed from *U. Krameri*, which I before dissected. Winkler does not describe the parts which I shall deal with in this paper.

As to the synonymy of the other species, which I call "*U. vegetans*" in this paper, it is not possible to speak with any confidence. The only thing which, I think, may be relied on is that the creature spoken of is identical with the *U. ovalis* of Kramer, which, as above stated, I do not think is really Koch's *ovalis*. *U. vegetans* was originally described by de Geer,§ who calls it "*Acarus vegetans*," the genus *Uropoda* having been originated by Latreille.‖ De Geer's figure and description were probably taken from immature specimens ; they are not sufficient to identify the species, but they do indicate a creature the shape of Kramer's *ovalis*, and the immature forms of which attach themselves to insects in the singular mode so well known in this genus. De Geer does not say whether the first pair of legs are terminated by a sucker and claw, or by hairs only ; nor can this be gathered from the figures. Numerous early writers practically simply quoted de Geer, without throwing much further light on the subject.

* Fasc. xl. pl. ix. † Prosp. d. Acarofauna ital., Padua, 1885, p. 103.

‡ Arbeiten d. Zool. Inst. Wien, t. vii. Heft 3, 1888.

§ 'Mémoires pour servir à l'Histoire des Insectes,' Stockholm, 1778, t. vii p. 123, pl. vii. figs. 15–19.

‖ 'Genera Crustaceorum et Insectorum,' Paris, 1806–9, genus 62.

In 1876 Mégnin * described and figured a creature under the name of *U. vegetans;* his description is so slight, that it is not possible to make any use of it. There is, however, a large and well-drawn plate, which shows a species without any claws or suckers to the first pair of legs. I am not aware that any other acarologist has found any creature which really corresponds in all respects to Mégnin's *U. vegetans*, the known species in which the same shape exists having claws and suckers on the first pair of legs.

In 1881 Haller † asserted that Kramer's *U. ovalis* was really the *U. vegetans* of de Geer. In 1882 Kramer replied, pointing out that his *U. ovalis* could not be identical with *U. vegetans*, because *ovalis* had suckers and claws to the first leg, and a genital plate (female) of a different shape. This is undoubtedly true if Mégnin's figure be taken to represent the true *U. vegetans* of de Geer, but I am not aware of anything to show that it does, and as others do not find what Mégnin has drawn, it seems unlikely that it can have been de Geer's species. It seems to me far more probable, as Haller supposed, that Kramer's *ovalis* is the original *vegetans;* at all events, in my opinion it is not Koch's *ovalis*, and therefore if it be not *vegetans* it is nameless. If Dr. Kramer likes to treat it as being so, and to give it a new name, I am not wedded to the idea of its being *vegetans*, and should readily follow him; in the meantime I call it *U. vegetans*, and I think that that name is probably correct; at any rate, for the identification of the species called *vegetans* in this paper I refer to Dr. Kramer's *ovalis*. It is as well to state that all my specimens of this species for the present investigation come from the nest of one of the wild social bees (a *Bombus*). I have frequently obtained the species elsewhere, but not in such abundance.

Anatomy.

Uropoda ovalis Koch.

If an adult female *Uropoda ovalis* be laid on its back the large genital plate (epigynum of Berlese) will at once be conspicuous, exactly filling up the genital opening in the ventral plate. The form of this genital plate, which is a good specific character in *Uropoda*, may be judged of from plate IV. fig. 9. It will be seen that at its anterior termination, in the median line, is a bifid projection, like a two-pronged fork; one prong of the fork is usually a little longer than the other. This projection is shown on a large scale in fig. 10. It is composed of clear, almost colourless chitin, while the rest of the genital plate is dark, and is received in a very slight depression of the ventral plate. It springs from the extreme ventral edge of the genital plate, and is not nearly as thick as the edge of that plate; thus, although the genital plate enters the genital opening, and forms

* Op. cit.

† Op. cit.

a door which closes it, yet this projection never enters, but always remains wholly external upon the ventral surface. A projection of the same nature exists in the same situation in almost all species of *Uropoda*, but the form differs greatly in the respective sorts; in some species the projection is so thin and transparent that it usually is not noticed when it lies against the body of the creature. As to the use of this projection, it might be suggested that it is to prevent the genital plate from passing too far into the genital opening; but this can hardly be so, because within that opening is a ledge (fig. 13, *d f*) running all round the opening except its posterior, or hinge, side, and which manifestly fulfils this office. The function of the projection, therefore, probably is to form a handle which may enable the genital plate to be pulled downwards from the exterior, turning on the ginglymus hinge at its posterior edge, and thus exposing the genital aperture.

Inside the upturned edge of the genital plate lies a membranous spoon-shaped piece (fig. 2, *g m*), which roughly follows the shape of the plate, but is not a lining in the sense of being attached by its whole surface.

When the genital plate has been removed, or turned down out of the way, it may be seen that the genital opening is the entrance to a chamber of which the genital plate, when closed, forms the floor; this chamber is the vestibule; a large portion of its roof, lying along the median line, is composed of the organ which I propose to call the perigynum (figs. 2, 3, 4, 5, &c., *pg*), and which, I think, has not previously been described. From the edge of the perigynum a flexible membrane extends outward, forming a dome, the lower edge of the membrane being attached round the genital opening. It must not be supposed, however, that the domed shape is the ordinary condition of the chamber; quite the contrary is the case. The perigynum is a stiff structure with chitinous strengthenings, the membrane is extremely flexible; thus the perigynum, when not drawn upward by muscles, falls until its lower surface approaches the genital plate, the membranes folding to allow it to do so; thus in its usual position the membrane runs upward from the edge of the perigynum, not downward. If a hair be introduced through the genital opening and pushed gently against the perigynum, then that organ will be raised, extending the membrane, and disclosing the true shape and nature of the vestibule. It will be seen hereafter that the perigynum is provided with muscles specially adapted to do what has been artificially done by the hair.

In addition to the great genital aperture there are two smaller openings into the vestibule, both from within; one is the entrance to the receptaculum seminis, the other the entrance to, or perhaps it should rather be said the exit from, the vagina; the latter is usually closed by, and always hidden by, the perigynum, until disclosed by dissection.

To commence with the receptaculum seminis. I did not describe or find such an organ in *Uropoda Krameri*, nor am I aware that it has been described in any *Uropoda*, or indeed in any of the *Gamasidæ*; nevertheless in *Uropoda ovalis* it is a large and unmistakable organ, which, in most of the numerous specimens that I dissected, was full of spermatozoa; and it will be seen further on that receptacula seminis exist also in *U. vegetans*, although they differ widely from the azygous organ of the present species.

The position of the receptaculum seminis in *U. ovalis* is shown in figs. 1, 2, *rs*, and the organ itself on a larger scale is drawn at fig. 8. It is placed longitudinally and horizontally in the median line, and runs below the vagina; it is long and sac-like, widest at its posterior extremity, with a concave hind margin and rounded posterior corners; it narrows gradually until near the mouth, when it widens again more rapidly, and its anterior edge is attached to a chitinous strengthening bar (fig. 8, *ar*). This bar is not straight; its shape may be best gathered from the figure; its central portion forms a pointed arch, which stands in a sloping direction upward and backward. The bar is sunk in the wall of the lower part of the posterior end of the vestibule, and the arch therefore forms an entrance from the vestibule to the receptaculum seminis, which is fairly accessible from the exterior after the genital plate has been got out of the way.

Above the opening of the receptaculum seminis, still in the median line, but near the top of the wall of the vestibule, is the opening of the neck of the vagina (fig. 2, &c., n^1). The vagina itself is a more or less globular organ, sometimes slightly constricted in the middle; it has thickish muscular walls, and is capable of considerable distension. It is quite of the type of the same organ in *U. Krameri* and in the *Oribatidæ*. The neck, however, exhibits some difference, viz. at the anterior end the vagina is suddenly contracted by powerful ring-muscles, so as to form a narrow neck *n*, which is also provided with longitudinal muscles. This neck finally expands again, still retaining its muscular and folded condition, and curves forward, its upper edge overhanging the lower (fig. 5, n^1); this upper edge overlies, and is attached to, the posterior end of the perigynum (fig. 3). The lower and lateral edges of the expanded neck of the vagina are not attached to anything, except that to each lower angle, near the edge of the opening, a tendon (fig. 6, t^3) is attached. This tendon is the termination of a muscle (m^3) which itself arises from the ventral plate, and, when in action, would draw the lower edge of the neck downward and backward.

The perigynum (fig. 7, and figs. 1, 3, 4, 5, &c., *pg*) is a very singular structure; it is best described as being somewhat of the shape of a shoe, concave on its dorsal and convex on its ventral surface. The heel of the shoe turns sharply upward (figs. 6, 7), and ends in a narrow portion (figs. 3, 4, 7). The upper edge, or framework, of the heel of the perigynum is composed of a strong chitinous bar,

which extends about half-way along the edge on each side; thence nearly to what may be called the toe of the shoe it is continued by a much thinner bar, which, however, is not absolutely joined to the thicker. The whole space inclosed by this framework is filled by a moderately thick lamina of chitinized tissue, having the concavo-convex form before described. This lamina is transparent and colourless, but is not flexible; it retains its shape permanently, and a transverse section of the perigynum shows this most distinctly. The dorsal side of the lamina is smooth; the ventral side is thickly covered with spines of moderate length. When the organ is seen from the dorsal side the proximal ends of these spines are seen through the transparent material, giving a dotted appearance.

Round the chitinous bar at the upper edge of the heel of the perigynum is fitted a piece of clear colourless chitin (figs. 3, 4, ch^1), and it is here that the upper edge of the neck of the vagina rests upon, and is attached to the perigynum; the thin projecting portion of the heel of the perigynum actually enters the opening of the neck of the vagina (fig. 6).

A powerful fasciculus of muscles (figs. 2, 3, 5, 11, &c., m^2) is inserted in the chitinous framework on each side of the heel of the perigynum just after it has curved round and become lateral; these muscles arise from the dorsal surface, and serve to draw the heel of the perigynum upward.

The thin membranous walls of the vestibule, although attached all round the perigynum, do not in all parts run simply from that edge to the genital aperture; round the toe of the perigynum they make a large fold (figs. 2, 3, *f*), which, to continue the former homely simile, looks like the toe of a larger slipper projecting beyond the shoe.

Round the edge of rather more than the anterior half of the perigynum extends a membranous vandyked border (figs. 2, 3, 4, 7, &c., *fr*), the proximal edge of which is attached to the ventral side of the framework, while the whole of the remainder stands free inside the vestibule. This border is very conspicuous in stained dissections, as it takes stain readily; but I cannot at all suggest what is its office.

Two paired accessory glands (figs. 1, 2, *ag*) discharge close to the mouth of the vagina; they are sac-like organs of even diameter throughout, the diameter being small compared to the length; about the middle they are bent nearly at a right angle.

Having now described the whole of the parts, it remains to indicate what it appears to me is their action. Firstly, when the receptaculum seminis is being filled, and at ordinary times if the genital plate be opened, the heel of the perigynum would rest against the opening of the neck of the vagina, its spines probably interlocking with some spines which exist round the neck, and thus spermatozoa and foreign substances would be completely excluded. When it is necessary that spermatozoa should enter, then the action of the

muscles m^4 would expel a sufficient number from the receptaculum, and the action of the muscles m^2 would raise the heel of the perigynum and allow the opening of the neck of the vagina to be entered. Again, when oviposition is to take place, the large egg would be forced from the vagina through the neck, the powerful muscles m^2 would raise the perigynum, carrying the top of the neck of the vagina with it; the opposed muscles m^3 would at the same time draw down the lower edge. Thus the neck of the vagina would be drawn from what may be termed its four corners and its opening widely expanded, while it would also be somewhat drawn away from the lower part of the heel of the perigynum. The egg would thus be allowed to pass through the neck of the vagina into the vestibule, slipping under the heel of the perigynum. From the vestibule it would reach the exterior through the genital aperture.

Uropoda vegetans.

The female genital organs in this species are on the whole of the same type as those of *U. ovalis*, but there are some very marked and singular differences. Fig. 12 will show that the central ovaries and oviducts are again of the usual form, and present little variety; the vagina also is similar in construction, but it is larger in proportion and more elliptical than the corresponding part in *U. ovalis*. The neck of the vagina is even more tightly constricted than in the last-named species, but the actual mouth of the organ is more expanded, and is not closed by the heel of the perigynum, as in *U. ovalis*. The apparent reason for this will be seen shortly. The perigynum exists in the present species, and considerably resembles that described above. In this case, however, the chitinous bar round the heel is very thin and delicate, the stronger portion of the framework being the anterior lateral; this consists, not of a rod, but of a blade on edge (on each side). The concavo-convex form is not nearly so marked, the organ being nearly flat in transverse section, nor does the heel curve in the manner shown in fig. 5; it is much more suddenly bent upward at an angle, and there is not any narrow portion projecting backward into the vagina. On the contrary, the top curls over slightly in a forward direction (fig. 12, &c.). The spines on the ventral surface of the perigynum are confined, in this species, to the heel; they are shorter than, and very different in form from those of *U. ovalis;* they are chitinous points, generally united at their bases into little transverse lines of three or four, each group standing well apart from the next. They remind me of the teeth on the radula of some Gasteropods; they are represented in fig. 18. The flexible walls of the vestibule are attached all round the edge of the perigynum, as in *U. ovalis*, but there is not any vandyked border at the juncture, nor anything substituted for it; nor is there any great fold of the membranous wall, such as *f* in fig. 3.

The first great difference between the two species which is noticed is the entire absence in *U. vegetans* of the large azygous receptaculum

seminis found in *U. ovalis* ; further examination shows that its place is supplied by two very small paired organs of a totally different form (fig. 21, and figs. 12, 13, 14, *rs*). They greatly resemble the corresponding organs of *Musca domestica*, as figured by Stein, and each consists of a quite small elliptical sac, which is placed at the distal end of a long narrow tubular peduncle, which is slightly constricted at regular intervals near the sac, so as to present a somewhat moniliform appearance. The peduncle has a larger diameter at its distal end than at the proximal, where it arises from the upper side of the expanded neck of the vagina. It is probably because of this position of the entrance to the receptacula seminis that the mouth of the vagina is not closed by the perigynum, as in *Uropoda ovalis*, the closing of the entrance to the vagina being apparently effected in *U. vegetans* by the tighter constriction of the neck. When the organs are dissected out, the receptacula seminis appear dark and chitinized, although the peduncle is comparatively light and transparent; if, however, the sac be torn, and its contents expelled by pressure, it will then be found that the apparent darkness and opacity arise from the receptaculum being (in all specimens which I have dissected) so densely crowded with spermatozoa that they form a solid mass, which may be pressed out and retain its elliptical shape; a drop of liquid, or a little disturbance with a fine hair, will, however, soon resolve the mass into its constituent parts, viz. spermatozoa, such as those represented by fig. 20. When the spermatozoa have been expelled the walls of the receptaculum are nearly transparent and smooth; while they are still contained in it the organ looks granular, from the closely packed spermatozoa showing through the walls.

There are two paired accessory glands in this species, as in *U. ovalis*, which discharge into the vestibule near to the mouth of the vagina, but instead of being sausage-shaped they are almost globular; their walls are thin and transparent, and have a few straight wrinkles arranged in a radiating manner; an extremely short duct leads from them to the vestibule. The glands of *U. ovalis* have generally been charged with secreted material when I have found them, while the more vesicle-like organs of *U. vegetans* have invariably been entirely empty. I fancy, however, that in consequence of the shortness and openness of the ducts their contents escape during dissection.

The accessory glands and the corner of the mouth of the vagina are supported on each side of the body by a singularly shaped chitinous piece, which is not present in *U. ovalis*, and which I will call the "sigmoid piece"; it is an S-shaped lamina, varying in width in different parts, and twisted also in a direction at right angles to the plane of the S, so that it becomes screw-like. It is difficult to give an idea of it in words; it will probably be understood better from figs. 13, 15, 17, *si*. The edge of the sigmoid piece is attached, at one place, to the lateral body-wall; the duct of the accessory gland discharges along the hollow formed by the lower turn of the S; the end of the upper turn supports the mouth of the vagina.

Uropoda cassidea.

I had only one specimen of this large and well-marked species to dissect, so that I was not able to carry on investigations nearly as satisfactorily as I was in the cases of the two species treated of above; it was, however, plain that considerable differences existed between the vestibule and surrounding organs of *U. cassidea* and those of any of the other species which I have dissected. The perigynum exists, and is large and conspicuous, but it consists of an almost flat plate, which is entirely surrounded by a broad chitinous band (fig. 22), nearly elliptical as regards its exterior margin, but retaining a little of the shoe-shape on its inner edge. The anterior part of the outer edge has a few large serrations projecting from it. The flexible wall of the vestibule is attached round the edge of the perigynum, as in the other species. The neck of the vagina is short, but is surrounded by a very powerful ring-muscle; the vagina itself is large, and is drawn out in a more or less triangular extension on each side, at the apex of which triangle the oviduct enters. In the single specimen which I had I was not able to detect any receptaculum seminis or accessory glands.

It now only remains to offer a possible explanation of the very considerable differences between the forms of the vestibule in all these species and that of the same organ in *U. Krameri*. In my paper on that species in this Journal * I suggested that the parts appeared eminently fitted to strip the shell from the egg as it emerged, and I called attention to the fact that the eggs found in the part of the oviduct near the vagina, in all cases which I had observed, contained larvæ fully, or nearly fully, developed; and in most cases apparently ready to emerge. It therefore seemed probable that the larva did emerge from the egg at the moment of oviposition, and that the vestibule removed the shell of the egg from it; cr, at all events, that this was the course at some periods of the year. In the species treated of in this paper the vestibule does not seem nearly as well fitted to perform this office as in *U. Krameri*, and it is an interesting fact that, although the eggs in the lower part of the oviduct had apparently attained their full size, and yolk-division had proceeded to some extent, yet not in one single instance among all my numerous dissections was there the least sign of a formed, or partially formed, larva in the egg. This may possibly be due to some difference of season or other cause, but the time of year did not differ much from that of the former investigation, the present being in August and September, the former in July and August; it seems probable, therefore, that in the species now considered the larva does not emerge from the egg until longer after its deposition, and this may well account for the differences in the structure of the vestibule.

* Loc. cit.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Weismann's Theory of Heredity.‡—Professor A. Weismann has published an important explanation of his views, in answer to a recent criticism by Prof. Vines. The difficulty which led the critic to regard it as "absurd to say that an immortal substance can be converted into a mortal substance" is due to a confusion of two conceptions—immortality and eternity. It seems to Weismann to be incontrovertible that the Protozoa and the germ-cells of the Metazoa are in a certain sense immortal; though we have to do with individuals of indefinite duration, it by no means follows that this duration is eternal, for these individuals must have had a beginning. Eternity, to express it accurately, is merely the negation of the conception of transitoriness. As was said years ago, the immortality of these cells is not absolute, but potential; it is not that they must live for ever, as the gods of the ancient Greeks; they can die—the greater number do in fact die—but a proportion of them live on. Here, as elsewhere, life depends on metabolism, or a constant change of material; that, then, which is immortal is not the substance, but only a definite form of activity. The cycle of life is like the circulation of water, which evaporates, gathers into clouds, and falls as rain upon the earth, always to evaporate afresh. As in the physical and chemical properties of water there is no inherent cause for the cessation of the cycle, so there is no clear reason in the physical condition of unicellular organisms why the cycle of life, i. e. of division, growth by assimilation, and repeated division, should ever end; and this characteristic it is which Weismann has termed immortality.

If then this true immortality is but cyclical, and is conditioned by

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Nature, xli. (1890) pp. 317–23.

the physical constitution of the protoplasm, why is it inconceivable that this constitution should be, under certain circumstances and to a certain extent, so modified that the metabolic activity no longer follows its own orbit, but after more or fewer revolutions comes to a standstill and results in death? Even if we cannot penetrate into the mysteries of the constitution of living matter, we may say that a rigorous and unceasing natural selection is unremittingly active in maintaining it at such an exact standard as to preserve its immortality, and every lapse from this standard is followed by death.

From the instant that natural selection relaxed its watch on this quality of immortality, the process of panmixia, which led to its abolition, began. When once individuals arose among monoplastids, in the protoplasm of which occurred such variations in chemical and molecular constitution as to result in a gradual check on the metabolic cycle, it would happen that these individuals died; a permanent variety could not grow out of such variations. But, if there arose among heteroplastids individuals with a similar differentiation of the somatic cells, the death of these cells would not be detrimental to the species, since its continuance is insured by the immortal germ-cells. After the differentiation into germinal and somatic cells natural selection was, speaking metaphorically, trained to bear on immortality in the germ-cells, but on quite other qualities in the somatic cells.

The recent observations of Klein on *Volvox* show that as soon as the germ-cells are ripe and emerge from the spheres, the ciliated somatic cells begin to shrivel up, and die in one or two days.

The immortality of living matter is not life without beginning or end, but life which, after its first commencement, can continue indefinitely with or without modification; it is a cyclical activity of organic material devoid of any intrinsic momentum which would lead to its cessation, just as the motion of the planets contains no intrinsic momentum which would lead to its cessation, although it has had a commencement and will some day, through the operation of extrinsic forces, have an end.

After pointing out the differences between "ideal" and "real" theories and the relation of his own theory to that of Darwin's theory of pangenesis, Prof. Weismann explains that his essays represent a series of researches, and urges that an early must not be set against a later expression of opinion. He does not recognize Prof. Vines' somatoplasm; his own idioplasm (or germ-plasm) of the first ontogenetic grade is not modified into the somatoplasm of Vines, but into idioplasm of the second, third, hundredth, &c., grade, and every one impresses its character on the cell containing it.

Our author is distinctly opposed to the rejuvenescence theory; he thinks we should not speak of the sexual elements as male and female, but as paternal and maternal; there is no opposition of the one to the other, they are essentially alike, and differ only so far as one individual differs from another of the same species. Fertilization is merely a union of the hereditary tendencies of two individuals, tendencies which are bound up with the matter of the nuclear loops; the cell-body of the ovum and spermatozoon is indifferent in this connection, and plays merely the part of a nutritive matter which is modified and shaped by

the dominant idioplasm of the nucleus in a definite way, as clay in the sculptor's hand. The different appearance and function of ovum and spermatozoon and their mutual attraction rest on secondary adaptations, qualified to insure that they shall meet and that their idioplasmata shall come into contact; and as with the cells, so the differentiation of persons into male and female is also secondary; the so-called sexual characters are nothing but adaptations to insure the union of the hereditary tendencies of two individuals.

Boveri has recently shown that Weismann and Strasburger are right in considering that the sperm-nucleus can play the part of ovum-nucleus and *vice versâ*, for he removed the nucleus from an Echinoid egg by agitation, introduced spermatozoa, got a regular segmentation and a complete larva which lived for a week. Furthermore, if eggs of *Echinus microtuberculatus* be fertilized with the spermatozoa of *Sphærechinus granulatus* (*sic* : ? *granularis*), larvæ are developed with the true characters of the second species. Although Weismann's first interpretation of the polar body of the metazoan ovum is probably not correct, his idea—that the first dominant protoplasm is different to that of a later period—is justified by subsequent researches; the last word has, probably, not yet been said on this question. Prof. Vines is probably right in questioning whether sexual reproduction is the only factor which maintains Metazoa and Metaphyta in a state of variability; at the same time, no one will dispute that it is a most active means of heightening variations and of mingling them in favourable proportions. Sexual reproduction has arisen by and for natural selection as the sole means by which individual variations can be united and combined in every possible proportion.

As to the inheritance of acquired characters, it is pointed out that Boveri's observations prove that, among animals, the body of the ovum contributes nothing to inheritance; if acquired characters are transmitted, they must be so by means of the nuclear matter of the germ-cells —in fact, by the germ-plasm, and that not in its patent, but in its latent condition.

Divergent Evolution and Darwinian Theory.*—The Rev. J. T. Gulick discusses his theory of divergent evolution under the heads of (1) Some degree of local separation under different environments; (2) Darwin's theory of natural selection through the advantage of the divergence of character; (3) Darwin's theory that exposure to different environments is essential to diversity of natural selection; (4) divergent forms of sexual selection, and (5) Darwin's reference to the causes which check the crossing of varieties. He concludes that, though Darwin has not recognized segregation, which is the independent propagation of different variations, as a necessary condition for the production of divergent races and species, he has pointed out one process by which segregation is produced in nature; this is geographical or local separation under different environments. This process is an important cause of segregation resulting in divergent evolution, but this is not the only cause producing segregation and divergence, for in some cases the isolated portions of a species, while exposed to the same environment, acquires divergent habits in the use of it; in other cases, without

* Amer. Journal Science, xxxix. (1890) pp. 21–30.

exposure to different environments the very process producing the isolation brings together those of one kind, as when individuals of a special colour prefer to pair together.

Degeneration of Ova.*—Prof. G. Ruge describes the degenerative processes in the egg-follicles of Vertebrates, especially in the unexpelled ovarian ova of Amphibians (*Siredon pisciformis* and *Salamandra maculosa*). The death of the ovum is followed by changes in the surrounding blood-vessels, and by a proliferation of the elements of the enveloping membranes. The dead ovum is penetrated by elements either belonging to the epithelium of the egg-cell or to the blood. The invading cells loosen the yolk material which is then removed by the vessels. Finally, in the shrivelled ovum, there remains only the material which is not readily absorbed. The whole follicle has a certain unity, and is implicated in the degeneration of the egg-cell. Prof. Ruge also gives a summary of similar processes observed by numerous investigators in fishes, reptiles, birds, and mammals.

Professor Rabl's Memoir on the Theory of the Mesoderm.†—Dr. R. S. Bergh, under the title of "Ein moderner Theoretiker und seine Methodik" has, as the title may lead us to suppose, a severe criticism on Prof. Rabl's theory of the mesoderm.‡

β. Histology.§

Morphology and Physiology of Cell-nucleus.‖—Dr. E. Korschelt has investigated the nuclei of ovarian and of secreting cells. In discussing the former he describes the change of form of the nuclei and their relations to their surroundings, taking as his chief text *Dytiscus marginalis*, but also other Insects, as well as *Antedon* and *Spinther*. The change of position of the nuclei is described in various Insects and Cœlenterates, and the structural changes of the nuclei of a number of forms are discussed. Under the same heads the nuclei of secreting cells are treated.

His investigations had the object of showing that the cell-nucleus is not only active during the multiplication of cells, but that it also exhibits its influence on the cells during the performance of other functions. For example, the nuclei of ovarian cells send out processes towards the region in which the cell is taking up substance, and in secreting cells processes of the nuclei are directed to that part of the cell in which secretion is going on. From this we must conclude that the nucleus in one case affects the ingestive, and in the other the secreting activity of the cell. Moreover, the nucleus often loses its sharp boundary-line in such places, and its contents appear to pass over into the cell-protoplasm; this indicates an intimate relation between the substances of the cell and of the nucleus.

The disappearance of the cell-boundary and the closer connection between nucleus and cell-substance effected thereby calls to mind the disappearance of the nuclear membrano in karyokinesis—a process

* Morphol. Jahrb., xv. (1889) pp. 491–554 (4 pls.).
† Zool. Anzeig., xiii. (1890) pp. 17-24. ‡ See this Journal. ante, p. 16.
§ This section is limited to papers relating to Cells and Fibres.
‖ Zool. Jahrb., iv. (1889) pp. 1–154 (6 pls.).

which has certainly been seen by many observers. There is no doubt that in karyokinesis the nucleus has an essential influence on the cell. There is an indistinct boundary in most of the branched nuclei of the nutrient cells of the ovaries of Insects, and often also in those of the spinning-glands of caterpillars; here, too, we may conclude that the nucleus exercises a direct influence on the cell. In secreting cells the indistinctness of the nuclear boundary is often manifest. In the nutrient cells of Insects' ovaries, in the spinning-glands of the larvæ of Lepidoptera, Neuroptera, and certain Hymenoptera the nuclei, without distinct boundaries, extend through the whole cell, send out processes, and ramify. In this way they are brought into close contact with all parts of the cell, and can thus best exercise their influence.

We cannot doubt that the nucleus takes up and gives off substance when we see how the nucleus increases and diminishes in size; this can be best followed out in the ovarian cells of *Dytiscus marginalis*. A change in the structure of the nucleus is connected with the share it takes in the activity of the cell; these changes find expression in the heaping up of masses of chromatic substance which disappear again later on. Nuclear bodies may be present in or absent from the nuclei, and in the former case, they may vary both in number and form. The germinal spots have, notably, had especial significance ascribed to them. In the young ovarian nuclei of Insects, and in the nuclei of the secreting double cells of the ovaries of *Nepa* and *Ranatra* there are large bodies which, later on, partly disappear. The nuclei of the spinning glands have very different structures at different times; the plexus has various phases of closeness, and by the disappearance of the network the nuclei get to have an empty appearance, and have a large quantity of achromatic substance in their interior. The nuclei of the spinning gland of *Cladius difformis* present other characters; the nuclei of the glandular cells are at first spherical, but later on they branch, and at last appear only as thin filaments of homogeneous structure which stain deeply.

The author discusses the views of previous writers on the function of the nucleus, and comes to the conclusion that the separation of the nucleus from the cell-protoplasm is only apparent. In reality there are close connections between them; where there is a nuclear membrane, there may be diffusion, or there may be spaces in the membrane by which the two may communicate, or there may be no membrane when the network of the nucleus passes directly into that of the cell-protoplasm. At different times the nucleus has different relations to the plasma, and these are sometimes closer than at others; there is no doubt that this is connected with the functions of the cell in which the nucleus takes part. But the removal of the boundary does not always seem to be sufficient, for in some cases the nucleus changes its position, and makes its way to the part of the cell which is in the greatest activity. The change in form may be temporary or permanent. The influence of the nucleus does not appear to be requisite for all the manifestations of the activity of the cell—for example, the non-nucleated parts of Algar cells were found to be capable of assimilation, but they were, on the other hand, unable to form a new cell-membrane. Non-nucleated particles of Infusoria are incapable of replacing lost parts, while nucleated pieces do so easily.

Karyogamic Reduction in Oogenesis.*—M. A. Lameere publishes an abstract of a memoir which has for its object the demonstration of the view that the polar globules cannot represent the elements eliminated from the egg to be replaced by the nucleus of the spermatozoon. Prof. E. Van Beneden has lately shown that in the division of the spermatogonia of *Ascaris megalocephala* there is an expulsion of polar globules, and he comes to the conclusion that the ripe ovum and the spermatozoa are homodynamous. The author reports the discovery, in the narrowest portion of the ovary of the just-mentioned worm, of residual corpuscles, identical in structure and probably in origin with those of spermatogenesis. After a number of direct divisions the nuclei of the primitive ova exhibit kinesis, and two chromatic loops are expelled, which appear to together constitute a residual corpuscle. These bodies are at first hyaline. The author concludes, therefore, that the ovum and the spermatozoa undergo, in a parallel manner and under the form of the expulsion of residual corpuscles, the karyogamic reduction which indicates the formation of pronuclei.

Karyokinesis in Larval Amblystoma.†—Mr. J. A. Ryder reports that a species of this genus of Urodeles affords by its embryos exceedingly interesting subjects in which to study karyokinesis and indirect cell-division. Nuclear spindles could be easily detected in all the tissues of the body in the greatest variety of stages. This creature is an excellent subject for histological teaching, as it illustrates the fact that karyokinesis is universal and holds with respect to all the tissues during the early stages of development. As the cells are very large, the spindles are also so; the filaments of chromatin are very large, thick, and sharply defined, so that all the phases of nuclear metamorphosis may be readily traced with moderate powers.

To prepare the embryos, they were killed and hardened with corrosive sublimate or Kleinenberg's picro-sulphuric acid. After hardening and washing in alcohol, the embryos were stained *in toto* in a dilute solution of hæmatoxylin, Kleinenberg's or Delafield's answering admirably; the chromatin threads being deeply stained with the dye contrast with the rest of the substance of the cells. Sections should be made in transverse as well as in vertical and horizontal planes.

Leucocytes in Tail of Tadpole.‡—Herr A. Looss in a memoir discusses the share taken by leucocytes in the destruction of the tissues of the tail of the tadpole. It would appear that Metschnikoff's conclusions have been given too wide a bearing, for in the metamorphosis of the frog they play a much more subordinate part than in the Diptera and invertebrate animals generally. The leucocytes would seem to form a kind of reserve force for the animal body which only comes into prominent use if the organism is unable, with the ordinary means at its disposal, to perform certain extraordinary duties, or to struggle against special difficult relations. Herr J. H. List remarks that we have in the doctrine of Phagocytes another example of a generalization made without sufficient critical observations in Invertebrates and Vertebrates.

* Bull. Acad. Roy. de Belgique, lix. (1889) pp. 712–4.
† Amer. Natural., xxiii. (1889) pp. 827–9.
‡ Biol. Centralbl., ix. (1889) pp. 595–9.

Origin of the Red Blood-corpuscles.*—Sig. F. Sanfelice maintains that the red blood-corpuscles originate from leucocytes within the medulla of the bones in the four highest classes of Vertebrates, and within the lymphoid tissue of Elasmobranchs. In mammals the hæmatic transformation, invading the nucleus, occasions its disappearance. The giant cells of the medulla of mammals are due to the leucocytes of the matrix or to young nucleated red blood-corpuscles; both kinds are retrograde fusions of cells and nuclei. Bleeding or reduction of nutriment increases the karyokinesis of the leucocytes. In the non-functional medulla of the long bones of the fowl there are reserve lymphatic accumulations ready to be changed into red blood-corpuscles. The elements found in the lymphoid tissue at the sides of the œsophagus and in the gonads of Selachians are identical with the constituents of the medulla in higher Vertebrates.

γ. General.

Marine Phosphorescence.†—Dr. E. v. Marenzeller has published an instructive lecture on this always interesting subject; attention is drawn in it to the work of Prof. B. Ratziszewski, which, though published in 1880, is not widely known in this country.

Deep-water Fauna of Clyde Sea-area.‡—Mr. W. E. Hoyle has made a critical examination of the species collected, chiefly by Dr. John Murray, in an extensive series of dredgings in various parts of the Clyde area. The richest fauna is in those basins that are in closest proximity to the sea, and the wealth diminishes as we proceed into the more land-locked portions of the district. Most of the species are dispersed more or less widely over the north temperate regions of the globe, while the smaller half is very unequally divided between northern and southern species, the former being five times as numerous as the latter. It would seem that the bottoms of the remoter basins have a fauna which approaches the more seaward basin in respect of variety more nearly than do their faunæ taken as a whole. It is possible that, in these basins, there is, in addition to the fauna derived from the present outer seas, a fauna which has been in them for a much longer period. The Clyde deep-water fauna has marked Arctic and Scandinavian affinities.

B. INVERTEBRATA.

Fauna of Transcaspia and Khorasan.—Dr. O. Boettger and Dr. A. Walter report, the one on the Mollusca § and the other on the Galeodidæ ‖ and Crustacea ¶ collected by Dr. Walter in the land lying east of the Caspian and in Khorasan. Only forty-nine Molluscs were collected, and this number is too small to allow any faunistic comparisons which could be regarded as satisfactory. Dr. H. Simroth adds some notes on the anatomy of *Lytopelte* and *Parmacella*. Seven species of Galeodidæ were collected, among which is a new genus called *Karschia*.

* Bull. Soc. Nat. Napoli, iii. (1889) pp. 143–68 (2 pls.).
† 'Ueber Meerleuchten,' Wien, 1889, sm. 8vo, 27 pp.
‡ Journ. Linn. Soc., xx. (1889) pp. 442–72 (1 map).
§ Zool. Jahrb., iv. (1889) pp. 925–92 (2 pls.).
‖ T. c., pp. 1095–1109 (1 pl.). ¶ T. c., pp. 1110–23.

Of the Crustacea, the Isopoda and Amphipoda are alone reported on in this number.

Relationship of Annelids and Molluscs.* — M. A. Giard draws attention to a report of the Academy of Sciences in which M. Roule is credited with pointing out the relationship of Annelids to Molluscs; and he gives quotations from papers of his own, one as early as 1876, in which that affinity was urged. He found some difficulty in homologizing the schizocœle of the higher Gymnotoka (= Mollusca, Annelida, Brachiopoda, and Ciliata), with the enterocœle of such lower members as the Brachiopoda and *Sagitta*. Now, however, he feels he may generalize; he finds that when, in the development of allied animals, an organ sometimes arises by a process of invagination or folding and at other times by cleavage or hollowing out, the latter mode of formation is to be considered as a condensation of the former. M. Giard has not seen in any of the embryonic Annelids which he has studied, the syncytium described by Roule; indeed, the contours of the ectodermic cells may always be demonstrated by suitable reagents.

Mollusca.

Sensory Organs of Lateral Line and Nervous System of Mollusca.† —Dr. J. Thiele was led to investigate the sensory organs of the lateral line in Molluscs from a suspicion that the abdominal sensory organs of Lamellibranchs might be the homologues of those found in the Capitellidæ. In a small Mediterranean *Chiton*, which perhaps deserves to be placed, on account of its peculiarities, in a special genus, eye like organs were seen which presented considerable differences from those described by Moseley, and in addition, there were movable setæ at the sides of the body which appeared to be tactile organs. In the nervous system the swellings of the dorsal ring which are regarded as cerebral ganglia, the direct connection of the latter with the anterior visceral ganglia, and, above all, the numerous connectives between the ventral and lateral cords are of importance. The author has observed in a *Proneomenia* hypodermal processes, which are similar to those described by Hubrecht in *P. Sluiteri*, but they differ in having no spicules, and are regarded as sensory organs. Young specimens of *Arca Noæ* have in the anterior part of the mantle two proportionately large pigment cups, the concavity of which is directed to the sides. Lateral organs such as those known in *Fissurella* and *Trochus* have been discovered in *Haliotis*, and are described by the author; these are not limited to the epipodium, but are found also on other parts of the body. The cephalic tentacles are regarded as the anterior terminal tentacles of the epipodium.

The nervous system of *Haliotis* is described as having the upper œsophageal ring divided into three portions which lie one above the other; of these the lowermost becomes separated to form a commissure beneath the œsophagus, while the two others pass into the pleuropedal connectives.

Proofs are afforded by comparative anatomy that the upper œsophageal ganglia of Polyclads, Annelids, and Solenogastres are not

* Comptes Rendus, cx. (1890) pp. 90-3.
† Zeitschr. f. Wiss. Zool., xlix. (1889) [1890], pp. 385-432 (2 pls.).

homologous with the cerebral ganglia of Molluscs, but that these centres rather correspond to the lateral œsophageal ganglia of *Neomenia.* Structures homologous with the small œsophageal ring of Solenogastres are found in Annelids, *Chiton*, *Haliotis*, *Dentalium*, and *Meleagrina;* there are no anterior visceral ganglia in Solenogastres or Annelids, but they are to be found in all true Molluscs, except Lamellibranchs.

Homologues of the sensory organs of the lateral line of Chætopods are to be seen in the sensory organs found at the edge of the mantle of Lamellibranchs and in the epipodium of the Rhipidoglossa, while the gills of Chitons are derived from homologous cirri. It is in agreement with this that the ganglia of the lateral organs of Chætopods, the nerve of the edge of the mantle of Lamellibranchs, and the ganglia in the epipodium of the Rhipidoglossa are homologous with the lateral cords of the Amphineura, while the two ventral pairs of ganglia of Lamellibranchs, the anterior of which is the centre for locomotion, and the posterior for the protection of the animal, and the pedal ganglia of Gastropods correspond to the ventral cords of the ventral medullæ of Annelids.

It will be noticed that a distinction is drawn between the ventral cords, and the lateral cords and cerebral ganglia; this is justified by their modes of innervation, and largely also by the histological structure of the centres; the ventral cords and their homologues correspond, in their general characters, to the dorsal medulla of the Chordata.

a. Cephalopoda.

Tract of Modified Epithelium in Embryo of Sepia.*—Mr. W. E. Hoyle has found a trifid tract of peculiarly modified ectodermal cells near the posterior aspect of the body of embryos of *Sepia.* The three ridges are clearly visible by the naked eye in embryos 5 to 8 mm. long, and seem to have been noted by Kölliker who, however, gives an incorrect account of their origin. The cells are larger in all dimensions than those of the adjacent epithelium, so that the level of the body is slightly elevated where they are present; the contents of the cells are finely granular, and stain more deeply than those of the normal epithelium; the cell-boundaries become indefinite towards the superficies, and, in some cases, this part of the tract stains more deeply than the rest.

The presence of a similar organ has been observed in embryos of *Loligo* and *Ommastrephes*, but in them the median portion only was seen. The function of the patch is probably glandular; as to its homology the author can only suggest the shell-gland and the invaginated gland which has been described as existing at the posterior extremity of *Sepiella.*

Innervation of Arms of Cephalopoda.†—Sig. G. Jatta maintains the pedal nature of the Cephalopod arms, inasmuch as the brachial nerves originate, according to his investigation, from the pedal ganglion, to which the brachial ganglion may be considered accessory.

* Proc. Roy. Phys. Soc. Edinb., x. (1889) pp. 58–60.
† Boll. Soc. Nat. Napoli., iii. (1889) pp. 129–32.

β. Pteropoda.

Morphology, Classification, and Chorology of Pteropoda.*—Dr. J. E. V. Boas, from a close comparison of the thecosomatous and gymnosomatous divisions of Pteropods, comes to the conclusion that they ought to be regarded as two independent groups. They are both so close to the Opisthobranchiata that they may be regarded as suborders of that order of Gastropods; as the present names of Thecosomata and Gymnosomata are inconvenient, they may be respectively replaced by Eupteropoda and Pterota. As the groups are distinct, they must not be together compared with the Cephalopoda, but independently of one another; if the Thecosomata are compared with Cephalopods, they are seen to have no other point of comparison except the pallial cavity; and, if we consider the isolated position which the Cephalopoda hold in relation to the rest of the Mollusca, it becomes clear that this single point of resemblance cannot be regarded as an argument in favour of a closer connection between the two groups. The same considerations apply to the Gymnosomata—in a single point, the presence of suckers on their arms, they resemble the Cephalopoda. The author regards these resemblances as analogical only.

After discussing in detail the organization of the Thecosomata, Dr. Boas considers what place they occupy among the Opisthobranchiata. He thinks it obvious that they approach most closely to the Tectibranchiata. In a large number of these latter, as in the Thecosomata, there is a muscular gizzard, which is provided with a varying number of teeth or horny plates. In the Bullidæ, as in the Thecosomata, the liver is a compact organ, which opens behind the gizzard, and has two excretory ducts in the former and one in the latter. The genital organs, and especially the penis, are also very characteristic; in both the genital orifice is simple, the penis is a sac which can be evaginated, and only communicates with the genital orifice by a groove.

In the Thecosomata the cerebral ganglia are connected with one another by a long commissure, while all the other commissures are very short, so that all the large ganglia are placed near one another; of such Opisthobranchs as have had the anatomy of their nervous system adequately studied, the Bullinæ most resemble the Thecosomata. The existence of a well-developed shell and of an operculum in Limacina are further proofs of the author's position, for it is only in *Tornatella* (one of the Bullidæ) that there is an operculum. The Thecosomata are divided into the Limacinidæ, Hyaleidæ, and Cymbuliidæ, and their genera and species are described. The last-named family is the one which bears the strongest marks of adaptation to a pelagic mode of life—the "shell" is semi-gelatinous, the viscera are concentrated into a nucleus, the nuclei are reduced, the pigment is limited to the nucleus, and the rest of the body is transparent.

The Gymnosomata have their chief affinities also with the Tectibranchiata, as is shown by the characters of their generative apparatus; in other points there is not so close an agreement, but there is nothing to render it improbable. The characters which speak in its favour are the presence of a gill on the right side in some genera and the large number

* Skrift. K. Danske Vid. Selsk., i. (1886) 231 pp. (8 pls.).

of hook-like teeth in each row on the radula. Dr. Boas is not certain as to what members of the Tectibranchiata most resemble this group of "Pteropods"; the resemblance presented by *Gastropteron* may only be analogical.

The thecosomatous Pteropods have a very wide area of distribution, but may be separated into three groups: a small one found in cold northern waters, one limited to the temperate (and ? cold) seas of the south, while most of the species are found in all warm tropical and temperate seas in such a way that each species has its own northern and southern limit. Less is certainly known as to the geographical distribution of the Gymnosomata, but some species are very widely spread; in general their chorological characters appear to be similar to those of the Thecosomata.

γ. Gastropoda.

A Heteropod in British Waters.*—Prof. W. C. M'Intosh, by recording the capture of an *Atlanta* in St. Andrews Bay, has informed us of the presence of an example of a group of Molluscs formerly unknown in British seas. Hitherto they have been considered characteristic of the pelagic fauna of more genial waters. All recent investigations, however, tend to enlarge the area of truly pelagic types, and to raise the question whether temperature alone is the cause of the appearance in and disappearance from our seas of such types. Temperature certainly seems to have a marked effect on the vertical distribution of certain types and of the pelagic ova of fishes; but in the present case the influence of currents is probably of greater importance.

Reproductive Apparatus of Aplysiæ.†—M. E. Robert finds that this apparatus consists of five parts: the hermaphrodite gonad, the efferent duct, a complex organ to which he gives the general name of annexed genital mass, the common genital canal which opens on the right and in front of the gill, and the external genital groove. In the annexed mass the spermatozoa and ova become separated, and the latter are fertilized; albumen becomes added to the eggs, and shells are formed, each of which contains some scores of eggs, connected with one another and forming a continuous band arranged in heliciform shape, with closely approximated whorls; around these masses a cylindrical gelatinous sheath is formed. The efferent canal penetrates into the interior of the mass and opens into a cavity, which is a kind of vestibule or common chamber which communicates with several other organs. The albumen gland, which opens into this chamber, is hidden by the neighbouring parts, and can only be seen in the upper right region. To the left the common chamber is continuous with a glandular organ, which receives the name of "glande contournée"; its glandular walls are folded in such a way as to divide its cavity into a large number of small alveoli. The mucus-gland is formed by a very long hollow ribbon, provided in its interior with a double row of glandular lamellæ, between which there is a cavity. The common genital canal extends from the annexed mass to the genital orifice; it is divided into several special

* Ann. and Mag. Nat. Hist., v. (1890) pp. 47–8.
† Comptes Rendus, cix. (1889) pp. 917–9.

ducts, which are bounded by folds which project inwards. A large glandular duct formed of two applied folds extends from one extremity to the other, and divides the canal into two portions; the duct on the right is both oviduct and deferent canal, that on the left is the vagina, which terminates inferiorly in a cul-de-sac with which the terminal reservoir is connected; this is always filled with absolutely pure sperm. The external genital duct takes such a course as to make the vaginal orifice a special one, and this explains how it is that the animal which is playing the part of the female may be laying eggs at the same time that it has the penis of the male in the vagina.

It would appear that the organs function thus: the sexual products reach the common chamber, where the ova are fertilized by the sperm collected during copulation in the seminal reservoir; here, too, they get albumen. The products then pass into the twisted and mucus glands. When the animal emits the sperm follows the groove which is continued all along the erected penis and is introduced into the vagina of the female.

Glands of Aplysiæ.*—Sig. G. F. Mazzarelli describes the "opaline" or "grape-like," and the branchial or mantle glands in *Aplysiæ*. In *Aplysia limacina*, the glandular cells of the gill-cover emit a violet liquid only, while the opaline gland produces a white, or a purple, or a mixed white and purple secretion. In *A. depilans*, the opaline gland usually emits a white liquid only; the other gland produces the same, or plus a violet secretion. In *A. punctata*, the secretion of the opaline gland is white, or white and violet mixed, while that of the gill-cover gland is violet. There is thus no constancy in the origin of either liquid, nor has the observer discovered any reason why the secretion should be so variable. The secretion is protective, concealing the *Aplysia* in the exuded pigment, or disgusting enemies by the strong odour.

δ. Lamellibranchiata.

Nature of Byssus.†—Dr. R. Horst claims to have shown that the byssus-groove, in which the byssus-filament is formed, is continued into the byssus-cavity, into the wall of which it gradually passes; this cavity is, for its whole extent, surrounded by secreting gland-cells. When, therefore, a byssus-filament is formed, it is easy to understand that there is at the same time a secretion in the cavity, and in this cavity a lamella continuous with the byssus-filament is developed. As every successive lamella incloses its predecessor as in a sheath, and they all unite to form the byssus-stem, an increase in the number of byssus-filaments is connected with a growth in length and thickness of the byssus-trunk.

Hinge of Pelecypods and its Development.‡—Mr. W. H. Dall discusses the characters and development of the hinge of the shell of Pelecypods (more commonly known as Lamellibranchs), and attempts to form a better subdivision of the group than has been proposed hitherto. The author thinks that there can be but three fundamental types of hinge,

* Zool. Anzeig., xii. (1889) pp. 580–3.
† Tijdschr. Nederland. Dierk. Ver., ii. (1889) pp. 248–59 (1 pl.).
‡ Amer. Journal of Science, xxxviii. (1889) pp. 445–62.

which may be called anodont, prionodont, and orthodont. The last, in which the cardinal margin has become longitudinally plicate, hardly exists; in nearly all forms traces of the prionodont characters are mingled with it. For those forms in which the archaic anodontism still persists as the characteristic of chief importance, though frequently modified by special mechanical contrivances which to a certain extent mark the type, the term of *Anomalodesmacea* is proposed. Forms in which transverse plication of the hinge is the chief characteristic may be called the *Prionodesmacea*, while those which have the various types of hinge harmoniously combined are called the *Teleodesmacea*. Thus these groups may be regarded as orders, and each, as it now exists, contains archaic and modern specialized types; each has a tendency towards an ideal of fitness to the environment which results in a certain parallelism of minor characters common to minor groups in each of the three orders. In each certain members show affiliations with members of the other orders, and in each there are certain groups which represent a relatively modern specialization carried so far as to be quite peculiar.

The suborders of the Anomalodesmacea are:—1. Solenomyacea; 2. Anatinacea; 3. Myacea; 4. Eusiphonacea; and 5. Adesmacea. Of the Prionodesmacea:—1. Nuculacea; 2. Arcacea; 3. Naiadacea; 4. Trigoniacea; 5. Mytilacea; 6. Pectinacea; 7. Anomiacea; and 8. Ostracea. Of the Teleodesmacea:—1. Tellinacea; 2. Solenacea; 3. Mactracea; 4. Carditacea; 5. Cardiacea; 6. Chamacea; 7. Trinacreacea; 8. Leptonacea (?); 9. Lucinacea; 10. Isocardiacea (?); 11. Veneracea. The position of the Rudistes is uncertain, but they may be a specially modified and extraordinary branch of the Chamacea.

The author gives the reasons for preferring his views and classification to those of the late Dr. Neumayr, with whom, however, he is in agreement as regards many important points.

Fourth Pallial Orifice of some Lamellibranchs.*—Prof. P. Pelseneer finds that, when there are four openings in the mantle of a Lamellibranch, there is a relation between the fourth orifice and that of the byssogenous apparatus. In some forms in which the mantle is a good deal closed, and the foot as a locomotor organ reduced, while the byssus is considerably developed, the primitive pedal orifice is divided into two secondary orifices; the anterior of these remains a pedal orifice, the other is only used for the passage of byssus; such an arrangement was observed in *Lyonsia*. In Lamellibranchs with four pores, which are probably the descendants of forms organized like *Lyonsia*, the byssogenous apparatus is atrophied and the pallial orifice for the byssus has followed the retrogression; it is reduced to a small hole which is generally found at the point occupied by the byssal orifice of *Lyonsia*, and opposite the spot where the byssogenous apparatus is normally developed in Lamellibranchs. This fourth orifice may then be considered as the remnant of the opening which served exclusively for the passage of the byssus.

* Comptes Rendus, cx. (1890) pp. 154–6.

Molluscoida.

β. Bryozoa.

Critical Notes on Polyzoa.*—The Rev. T. Hincks has published the second part of his critical notes on Polyzoa, in which he deals with classification; the paper is too critical and controversial to be abstracted, but it appears to be of great value in the present state of the classification of this difficult group.

Development of Bryozoic Colony in Fertile Statoblasts.†—Herr F. Braem describes the statoblast from which a colony of Bryozoa arises as a mantle of ectodermal cells, which inclose a yolk-mass in which there are a number of nuclei. This mass is the product of those funicular cells which constitute the young statoblasts. While the protoplasm contained in the yolk becomes bounded off into cells around the nuclei, which, for the most part, lie close to the ectoderm, the basis is laid down of an internal epithelium which spreads out between the ectoderm and the yolk-mass. It grows by the deposition of new cells as well as by the ingestion of yolk-substance. In one region the ectoderm of *Cristatella* shows a marked change; as its cells increase considerably in size and height they form a cylindrical epithelium which soon gives rise to a definite germinal disc; this covers the greater part of the shell, but with a tendency to lie on one side. This disc is the rudiment of the first polypide of the future colony; its peripheral margin becomes more and more contracted as a circular groove sinks in from without; at the point where the margins of the groove fuse with one another the cervical portion of the bud is developed, and it is by means of this that the bud remains in connection with the body-wall. A further series of changes result in the differentiation of an anal and oral region in the bud. In front of the anus the rudiment of the central nervous system appears in the form of a slight depression of the inner layer of the bud, which corresponds to the outer ectodermal layer of the wall of the statoblast. Still nearer the mouth there is the sharply marked incision between the arms of the lophophore, which does not yet reach the oral base of the central cone; here, too, is an invagination which will form the œsophageal portion of the digestive tract; it curves towards the closed end of the anal tube, which has already attained a considerable size. The later processes are essentially the same as those seen in budding in the stock.

The author promises a full account of his investigations.

Arthropoda.

α. Insecta.

Evolution of Papilionidæ.‡—Prof. G. H. T. Eimer has given a practical illustration of his conclusions as to the origin of species,§ in a treatise on the varieties and species of *Papilio*. Taking the four

* Ann. and Mag. Nat. Hist., v. (1890) pp. 83–103.

† Zool. Anzeig., xii. (1889) pp. 675–9.

‡ 'Die Artbildung und Verwandtschaft bei den Schmetterlingen. Eine systematische Darstellung der Abänderungen, Abarten und Arten der Segelfalter-ähnlichen Formen der Gattung Papilio,' 8vo, Jena, 1889, pp. 243 (23 figs.); also an atlas with 4 folio coloured plates.

§ See this Journal, 1889, pp. 31–3.

groups (1) *Podalirius*, (2) *Antiphates*, (3) *Leosthenes-Anticrates-Ajax*, and (4) *Ajax-Policenes*, he seeks to show how the variations exhibit orderly progress along definite lines of evolution. Thus the ground-colour tends to pass from yellow into green; in (1) green appears at the roots of the wings; in (2) likewise and also at the angles; in (3) green predominates, and that completely in the American forms; in (4) the same is true. The colouring depends upon a pigment, its alteration on constitutional and environmental conditions. But the regularity of variation is even more striking when the markings—bands, lines, and spots—are studied, the author's contention being that all the variations are definite and progressive, sometimes towards greater complexity, but as often towards simplification.

"All the details, even the minutest, show that the origin of variations, varieties, and species, depends throughout on orderly physiological changes in definite directions. Various characters change *pari passu* in correlative or kaleidoscopic modifications. There is nothing in the origin of new characters which can be referred to adaptation or sexual selection in the Darwinian sense." Nor will Eimer allow that a more than probable explanation of progressive variations can be found in the "principle of utility," still less in "fortuitous variation of the germ-plasma." Varieties and species represent forms which have remained (in "Genepistasis") at definite stages of a consecutive progress. The four groups have a common starting-point, and the two *Ajax* groups also spring from one root.

Ventral Glands of Caterpillars.*—Dr. C. Schäffer distinguishes four kinds of glandular organs in caterpillars. In *Vanessa Io* the ventral gland is very short and undivided; the wall of the tube has everywhere the same lattice-like appearance. In *Plusia gamma* the tube is longer than in *Vanessa*, but is still undivided; an efferent portion may be distinguished from the secreting; when in a state of repose the tube is twice folded. In *Hyponomeuta evonymella* the glandular apparatus consists of two portions, one of which is distinguished by a peculiar plasmatic structure and an investment of a setigerous cuticle. In *Harpyia vinula* the secretory median pouch has, near its opening, on either side two lateral lobed appendages, from the walls of which rather long setæ project into the lumen. The median pouch is not tubular in form.

Alimentary Canal of Lamellicorns.†—Dr. P. Mingazzini continues ‡ his account of the alimentary canal of phytophagous Lamellicorns, dealing now with the adult insects. Representatives of six genera (*Oryctes nasicornis*, *Phyllognathus silenus*, &c.) were studied. The œsophagus of *Oryctes* is described at length, with its internal chitinous cuticle, a stratum of matrix cells, a layer of large salivary cells, a slight layer of connective tissue supporting the secretory cells, and finally muscular fibres. As a second type Mingazzini describes the fore-gut of *Anoxia australis*, which is more primitive, there being no marked difference between matrix cells and salivary cells. The mid-gut is very uniform throughout its course and throughout the series. Internally the epi-

* Zool. Anzeig., xiii. (1890) pp. 9-11.
† MT. Zool. Stat. Neapel, ix. (1889) pp. 266–304 (3 pls.).
‡ This Journal, *ante*, p. 30.

thelium bears the functional secretory and small matrix cells, and there are also special accumulations of small cells forming "gastric follicles." Then follow a subepithelial connective layer, transverse muscles, more connective, longitudinal muscles, and ensheathing connective. The changes in the secreting cells are discussed; they conform with those described by Plateau, Frenzel, and others. The hind-gut varies not a little in different species; a slender portion, a sac, and a rectum are present as in the larvæ, and have similar functions. Indeed, the whole gut of the adult corresponds functionally and structurally with that of the larva. The gut of *Anoxia* and *Anomala* (and the Melolonthidæ generally) differs but slightly from that of *Cetonia* or *Tropinota*, but is more primitive than that of *Oryctes* or *Phyllognathus*, facts which agree with the systematic relations of these genera. The surface or the length of the mid-gut increases as the nutritive value of the food diminishes. Mingazzini compares the salivary glands of *Scarabæus* with the salivary cells in *Oryctes*, *Anoxia*, &c., to show the gradual differentiation of these secretory structures. He is unable to find the fibrillar structure of the chitin described by Minot, nor does he believe in the existence of a chitinous stratum in the mid-gut, as maintained by Schneider.

Coleopterous Larvæ and their Relations to Adults.*—From the abstract of Mr. H. W. Conn's paper we learn that he has arrived at certain conclusions; they are based on the study of the larvæ of beetles; this group was selected as it shows the greatest amount of variation within a single order. A Campodeoid form was taken as the starting point, as it is the most widely distributed and has frequently been regarded as the closest living representative of the ancestral insect.

With the exception of the Campodeoid type, which is found in a number of families, all beetle larvæ have secondary modifications which have been introduced during the larval life of the beetles, and have never been represented by any adult features. Though they do not represent ancestral stages they may teach relationship, since the presence of a similar larva may indicate a recent common ancestor.

Amid the immense variety of larvæ four somewhat distinct types may be recognized; there is the Campodeoid, a type slightly and variously modified from it, a Scarabid type, and a maggot-like type, like that of the weevils. In many cases it is possible to determine definitely the sort of conditions that have produced the present type.

The division of larvæ into types seems to have no relation to the classification of adult insects into suborders, but that of the families of larvæ does run parallel to the classification of the families of adults. The many exceptions to this rule may, in part, be easily explained by differences in habit, and are most common in the degraded types of larvæ. On the whole, the present larval types of beetles are about as old as the families, but not much older. If we adopt the present classification of adult beetles we must own that the amount of departure from the primitive larval type that any family of beetles present is no indication of the position in the scale of classification that the adults should occupy. It seems probable that the larva has been the first to modify its habits, and that the adult has subsequently acquired habits

* Proc. Boston Soc. Nat. Hist., xxiv. (1889) pp. 42–5.

related to it; the larval stage would seem, therefore, to be more important than the adult; at all events it is more thoroughly protected, and is the first to be adapted to suit its surroundings. The larvæ of beetles are much more diversified than the adults.

Although habits and conditions that surround the larvæ have been very important features in the production of the present larval forms, some other force—which is undoubtedly heredity—has been at work in retaining them. The characteristics used for classifying adults cannot be used for the larvæ—thus the antennæ have an almost uniform shape, and the mouth-parts seem to have but little value; no similarity can be traced between the mouth-parts of any particular family of larvæ and those of the adults of the same family, but the mouth-parts of all beetles are more like those of adult beetles than they are like those of any other order of Insects. This is probably a case of precocious inheritance. In beetle larvæ there are numerous cases in which a similar larval type has been independently acquired in two or more families. Some of the above generalizations will probably be found to be applicable to all orders of insects, while others are peculiar to beetles.

Structure of Retina of Blowfly.*—Prof. B. T. Lowne returns to a subject on which there has already been much discussion, and criticizes particularly the memoir of Dr. S. J. Hickson, whom he accuses of making "an egregious misstatement of Dr. Weismann's nomenclature." He points out how Dr. Hickson and M. Carrière disagree, and allows that the former is right when he says that the nuclei of Carrière are not cells; they are developed from cells, and each consists of a bundle of fusiform rods. Hickson's nervous elements are "undoubtedly fine tracheal tubes," and his "neurospongium" or terminal anastomosis, which is inadmissible on physiological grounds, is no nerve-plexus at all, but the tracheal plexus, the sustentacular framework of Prof. Lowne's "retina." The author states that if the optic nerve be traced, its fibres are observed to run in larger or smaller bundles, invested in a very transparent sheath; they terminate in the palisade layer by entering the fusiform elements. The sheath is continued over these last, and terminates on the inner surface of the basilar membrane. The tracheal vessels ultimately pierce this membrane, and run between the great rods.

Prof. Lowne states that in size and structure the elements of the retina of insects are almost identical with those of vertebrates; the optic nerve terminates in the protoplasmic inner segment, while the outer is transparent, resists stains, exhibits longitudinal striæ, and swells up with water in both groups. In both it is easily destroyed, and frequently exhibits vacuolation. One difficulty in accepting the author's views has been the structure of the great rods, and he owns that their appearance is in many sections perplexing. In life they are hollow tubes filled and distended with fluid; in bad preparations they appear to be stellate in transverse section, and present no central cavity; in radial sections they are separated from each other by wide spaces which are often filled by distended tracheal vessels.

The results of a long research are to confirm in the main the

* Journ. Linn. Soc., xx. (1889) pp. 436–17 (1 pl.).

observations of Weismann on the development of the compound eye. Prof. Lowne comes to the conclusion that the retina is entirely formed as an outgrowth from the central nervous system, while the dioptron is formed from the external epiblast which is more or less invaded by mesoblastic elements.

Structure and Development of Ovaries of Blowfly.*—Prof. B. T. Lowne states that the "ovarian eggs" in the blowfly, and probably in other Insects, are yolks and contain no germ, while the so-called germ-glands are really germ-glands in which the germ-ova are developed. These ova pass into the yolks during their passage through the oviducts either as naked germinal vesicles, or as female pronuclei. The author urges the evidence of the observations made by himself, and the statements of other authors, when examined critically, as supports for the startling conclusions at which he arrives.

Habits and Metamorphoses of Eucephalous Larvæ of Diptera.†—Mr. F. Meinert has made a study of *Culex*, *Anopheles*, *Corethra*, *Mochlonyx*, *Chironomus*, *Tanypus*, *Dixa*, *Simulium*, and *Ceratopogon*.

He finds that the epicranium varies in size and extent; for it may occupy the whole of the superior region of the head as in *Corethra*, or only a third or a fourth as in *Dixa* and *Simulium*. The eyes may be large and compound as in *Culex* or very small and simple as in *Chironomus* and others. Though the ocelli are small they are sometimes larger than the true eyes. As a rule, the antennæ are large, but in *Ceratopogon* they can be only just detected. The scutum of the third metamere is ordinarily well developed, though here, again, there are exceptions; that of the second metamere is rarely very distinct. The sides of this metamere often carry a tuft of setæ or plates (rotatory organ) which attains the highest development in *Simulium*, although of large size in *Culex*, *Anopheles*, and *Dixa*. The first metamere (as opposed to the mouth) is always poorly developed or even rudimentary, and especially is this the case with the labrum. The labium is always devoid of palps, and has often the form of a strongly cornified layer, the anterior edge of which is denticulated. The maxillæ generally have only one large lobe; it is rare that there are two which are distinct. The palps are always distinct, except in *Ceratopogon*, where the maxillæ are altogether rudimentary. The mandibles may be simple, and have few or many rows of setæ, together with a large multifid tooth or a fan of dorsal plates.

The segments of the thorax are sometimes free and distinct; sometimes the anterior segment is alone free, and sometimes all three are almost fused. The nine segments of the abdomen are quite distinct; the eighth often carries two stigmata, either directly on the back or at the end of a rather long tube—the respiratory tube. In a larger number of cases the stigmata are completely wanting. Some species of *Chironomus* may push out two long tubular protuberances from the eighth segment. The ninth segment often carries a natatory fan. As a rule there are four anal papillæ, and a more or less large number of anal setæ at the extremity of this segment. *Corethra* and *Mochlonyx*

* Journ. Linn. Soc., xx. (1889) pp. 418–41 (1 pl.).
† Skrift. K. Danske Vid. Selsk., iv. (1886) pp. 373–493 (4 pls.).

have anal hooks. Pro-legs are sometimes found on the lower surface of the first thoracic, and of the last abdominal segments, but those of the former are often more or less fused. In *Simulium* they are completely fused and have the form of a cone, while the posterior pair is reduced to two feeble projections with a large number of microscopic hooks.

The respiratory apparatus varies greatly in the extent to which it is developed. In some genera there are two large longitudinal trunks which extend through the whole of the body of the larva and end by two open stigmata, while in other genera the apparatus is quite closed. The long trunks are divided into pieces which correspond to the segments of the body; in *Mochlonyx* the trunks keep their septa as a "souvenir de leur anastomose." Eight or nine pairs of solid lateral cords, ordinarily very delicate, pass from the epidermis to the longitudinal trunks. The tracheæ are at first full of serum, but later on become filled with air. When the tracheæ are renewed after ecdysis the old tubes are expelled to the exterior with a little air by the lateral cords, while the new tracheæ, which may be entirely filled with serum, have the serum only gradually driven out by the air in the body.

The trumpet-shaped organs of the nymph are at first filled with serum, but whether they have clefts or other openings, or whether they are closed, they become filled with air by the body. They are essentially hydrostatic organs or air-reservoirs, which serve to facilitate the last metamorphosis. The abdomen of the nymph ends in a pair of wide swimming-plates, and the last segment is wide and deeply incised; and this segment can scarcely be said to be a true respiratory organ.

The author concludes that the respiratory apparatus of Insects cannot be considered as a pure and simple formation of the epidermis, nor as resulting merely from the invagination of this layer. The connective tissue takes a more or less large part in the formation of the apparatus. In the larvæ here described the lateral cords essentially represent invaginations of the epidermis.

Ugimyia-Larva.*—Dr. F. Meinert gives an account of his own observations on the life-history of this larva, which imbeds itself in the Silkworm. He agrees with Prof. Sasaki, whose paper on the subject we noticed some time since,† in thinking that the eggs of the *Ugimyia* find their way into the body of the silkworm through its mouth, and he thinks it likely that other caterpillars are infested in the same way. The Ugimyia-maggot is only for a time located immediately inside one of the stigmata of the silkworm, and certainly does not form its bed "by heaping up fats and muscular fibres," for the bed is a widening or swelling of the trachea itself. This fact is fully in accordance with what is known of the parasitic life of many *Tachina*-larvæ. The plates of the spiracles or stigmata of the parasitic larva are quite closed, as is the case also in other *Musca*- and *Œstrus*-larvæ, with the exception only of *Gastrophilus*.

New Cattle-pest.‡—Mr. S. W. Williston has some remarks on a new cattle-pest in the United States which has been found on the horns of

* Ann. and Mag. Nat. Hist., v. (1890) pp. 103-12.
† This Journal, 1887, p. 579.
‡ Amer. Natural., xxiii. (1889) pp. 584-90 (1 pl.).

cattle, and in the hair along the flanks. After some time it was found to be identical with *Hæmatobia serrata* Robineau Desvoidy, from the south of France; it is suggested that its vernacular name should be "Horn-fly." It is distinguished from the common cattle-fly by its smaller size, and more especially by its long palpi; it has for its immediate allies some of the most vexatious of flies indigenous to various continents. It is very probable that the largest number of cosmopolitan insects are found among the Diptera, for they furnish the greater number of our domestic pests, and their eggs or larvæ are constantly mingled with our food-material or common objects of commerce. *Musca domestica* abounds even on the uninhabited plains of America. Some of such species are not, however, importations to America, as the Colorado Beetle and the Hessian Fly are sufficient to bear witness. Of the parasitic family of bot-flies, it is probable that all the (eight) species common to Europe and America have been introduced into the latter with the domestic animals, with the exception of the circumpolar reindeer bot-fly.

Anatomy of Ant-Lions.*—Dr. F. Meinert gives an account of his examination of the digestive tract of some larvæ of *Myrmeleon* which he found in Algeria. The mouth is not, as Hagen supposed, closed, but is merely compressed. The stomach is completely closed posteriorly, and the first part of the small intestine is a compact mass, with no lumen. There are eight Malpighian vessels, two of which are free, while the other six are connected with the small intestine; these vessels are ordinarily converted into silk-secreting glands, and the swollen part of the cæcum becomes the reservoir for this secretion. The remnant of the food of the larva is collected in the stomach, and is not expelled till the creature becomes a perfect insect; it is made up of an internal amorphous mass and an outer layer which contain phosphate of calcium and a large quantity of uric acid.

Prosopistoma variegatum.†—M. A. Vayssière gives an account of some larvæ of this species, which was regarded by its discoverer, Latreille, as an insect. These larvæ were aquatic and somewhat advanced in development, as the possession of wings showed. The species is much larger in size than its European congener, and the author was able, therefore, to extend his anatomical studies. There are six pairs of tracheal gills in the large respiratory cavity which is situated beneath the posterior half of the carapace; but the sixth, which are wanting in the European form, are much reduced, and cannot take any active part in respiration. As there are six abdominal segments and four caudal, we have the ten rings which are found in all larvæ of other genera of Ephemeridæ.

Studies in Pond Life.‡—Mr. C. M. Weed gives an account of some rather scattered observations on a series of particularly rich ponds in Ohio. The first deals with the life-history of the larger Typha-borer (*Arzama obliquata*); the larva, which is rather handsome, and swims readily by an undulating snake-like movement, is especially interesting on account of the peculiar position of two of the spiracles, which are

* Overs. K. Danske Vid. Selsk., 1889, pp. 43-66 (2 pls.).
† Comptes Rendus, cx. (1890) pp. 95-6.
‡ Bull. Ohio Agricult. Experiment Station, i. (1889) pp. 4-17 (2 pls.).

placed on the caudal margin of the eleventh segment. The tooth-horned fish-fly (*Chauliodes rastricornis*) belongs to a genus which has been little studied in the United States. The larvæ live in rude cells gnawed out of soft bark and wood; they ordinarily move by crawling along weeds, but, when alarmed, can swim rapidly by suddenly doubling the body up, bringing the head in contact with the abdomen. They have also a peculiar habit of walking on the surface of the water, body downward, and can thus move along quite rapidly. When handled the larvæ occasionally eject from the mouth a considerable quantity of a blackish fluid.

The most important element of food for the lesser water-bug (*Zaitha fluminea*) appears to be the larvæ and nymphs of dragon-flies; the undulating back-swimmer (*Notonecta undulata*) lives mostly on May-fly larvæ; they appear to have the power of ejecting a poison into their victims, as the author twice found that the insertion of their beaks into his skin produced a pain very much like that of a bee-sting. The aquatic beetle, *Donacia subtilis*, evidently plays an important rôle in effecting the pollenization of *Nuphar advena;* it is interesting to note that Müller found that a congeneric species in Europe aids in the pollenization of the European representative of the American yellow pond-lily. The thirteen-spotted ladybird was found to have a decided preference for aquatic plants. The paper concludes with some notes on the eggs of the giant water-bug (*Belostoma americanum* of Leidy or *Benacus griseus* of Say). Technical descriptions of larvæ, pupæ, and imagines are in many cases given.

Dorsal Gland in Abdomen of Periplaneta and its Allies.*—Mr. E. A. Minchin, who recently described † a pair of glands lying between the fifth and sixth abdominal terga of *Periplaneta orientalis*, has since dissected other allied species, in which he has found interesting variations of this organ. *P. americana* does not, so far, differ from *P. orientalis;* in *P. decorata* the glandular pouches are a little shallower and of greater lateral extent, and there is an additional gland which extends forward into the body-cavity; this gland and its ducts are proliferations of the hypodermis, and there is no invagination of the cuticle. *Blatta germanica* exhibits the greatest complication of structure, though the female seems to have no trace of the organ. In the male it is relatively of enormous size, projecting far into the body-cavity, and being quite visible externally. The sixth tergum is much larger than those in front of it, and has two very large oval depressions of considerable depth; each of these is further divided into two by a transverse ridge. The seventh tergum is still larger than the sixth, and emarginate in the middle line posteriorly; just under the projecting edge of the sixth tergum there is a large median opening, divided into two by a median longitudinal septum; these openings lead into large tubular invaginations of the cuticle and hypodermis. All the depressions and invaginations are lined by a tough brown cuticle of some thickness. Two kinds of hairs are present; some are stiff, straight, and pointed, and are of the kind found all over the body; others are very minute, short, and fine sensory hairs, which appear to be confined to the ridges

* Zool. Anzeig., xiii. (1890) pp. 41–4. † See this Journal, 1889, p. 204.

which divide the depressions of the sixth somite, and each is connected with a nerve-filament. The hypodermis between the cuticle and basement-membrane is enormously thickened in the organs of both the sixth and seventh somites; it contains a layer of small nuclei, which lie close under the cuticle, and each of which belongs to a narrow elongated cell; other nuclei belong to large, elongated granular cells, which rest on the basement-membrane, and interspersed there are numerous slender nerve-filaments, with elongated fusiform nuclei at intervals.

β. Myriopoda.

Myriopod producing Prussic Acid.*—Herr E. Haase calls attention to *Paradesmus gracilis* C. L. Koch, which is found endemic in many parts of the world, and has become established in some gardens in Europe. The formation of the acid was first demonstrated by C. Guldensteeden-Egeling, and the anatomy of the secreting organs made out by E. Weber.

γ. Prototracheata.

Movements of Peripatus.†—Herr E. Haase gives an account of some observations on the movements of *Peripatus capensis*. Speaking generally, they call to mind the movements of the Diplopoda, and especially of the Craspedosomata. Before beginning to move, the animal often raises its head and the next one or two succeeding segments and puts its tentacles in movement; if they are withdrawn quickly there is often a simultaneous contraction of the body. Like the Chilopoda, and especially *Geophilus*, *Peripatus* can move as well backwards as forwards. The line of movement on blackened paper is quite straight, whereas in Chilopods the body makes distinct lateral curves. When moving, the feet touch the ground at a much sharper angle than, for example, in *Lithobius*. The movements of *Scolopendrella* appear to be quite similar to those of *Peripatus*. As in Myriopods, the legs of a small group of segments alone move, while the others remain still; if a young *Peripatus* is repeatedly touched it rolls up, like the larva of one of the Tenthredinidæ; a young specimen was able to climb up vertical glass walls, but it could not hold on to the lower surface, a proof that its power of attachment is not due to the secretion of a sticky material. These creatures are able to move very quickly.

When the movement was slow, Herr Haase observed five waves of movement through the series of legs, just as he had observed in Chilognatha; when the young moved rapidly the movements of the legs were so rapid as to recall galloping movements, such as are made by caterpillars. In the larger specimens there are alternate movements, legs 1, 4, 7 of one side being often followed by 2, 5 of the other.

δ. Arachnida.

Development of Hydrachnida.‡—Herr F. Koenike finds that the sexes of Hydrachnids may, during the developmental stages, be recognized by differences in size. After the last ecdysis increase in size occurs in all parts except the maxillary organs, palps, epimera, feet, and

* SB. Gesell. Naturf. Freunde, 1889, p. 97.

† T. c., pp. 148–51.

‡ Zool. Anzeig., xii. (1889) pp. 652–5.

genital area. The porous chitinous carapace of *Arrenurus* is only gradually developed after the final ecdysis. The appendage of the body of the immature male of the same genus is in a rudimentary condition after the last ecdysis. All eight-footed *Nesæa*-larvæ have four genital acetabula, which are arranged by pairs.

Unrecorded British Parasitic Acari.*—Mr. A. D. Michael describes three species of parasitic Acari which appear to be new:—*Myocoptes tenax*, from the field-vole (*Arvicola agrestis*), is the second member of its genus; both species live on rodents among the hairs, to which the females of the new species cling so tenaciously that the grasp is often not relaxed even in death. *Symbiotes tripilis* is parasitic on the hedgehog, along and between the quills of which it runs up and down with great rapidity; unfortunately, the male of this species has not yet been discovered. The third form is the representative of a new genus—*Goniomerus musculinus*—which it is very difficult to define accurately, as the present form is so extremely minute; it was found on the surface of, or very slightly buried in a depression of the skin lining the inner side of the external ear of the short-tailed field-vole (*Arvicola agrestis*). The author gives detailed accounts of these three new forms.

Types of Metamorphosis in Development of Crustacea.†—Mr. I. C. Thompson made this the subject of his last (1890) address to the Liverpool Microscopical Society; as he well remarks, the student of minute pelagic forms often meets with immature forms, many of which are crustacean larvæ, and their study is by no means easy.

Brachyura and Anomura.‡—Sig. G. Cano describes the crustaceans of these orders collected on the "Vettor Pisani" expedition. The list includes a dozen new species, and two new genera—*Podohuenia* in the family Periceridæ, and *Euryetisus* in the family Cancridæ.

Excretory Organs of Gammarus.§—Sig. A. Della Valle having sprinkled carmine powder on the water tenanted by young forms of *Gammarus pulex*, found after several days that the pigment-granules had accumulated within the animals in the antennary gland, and at the bases of the maxillary, thoracic, and abdominal appendages. The granules in the antennary gland were very numerous, minute, and altered in colour; those at the bases of the appendages remained bright red. His experiments, though not sufficiently extended, suggest the excretory significance both of the antennary gland, and of those on the thoracic and abdominal appendages.

Paracopulation in Eggs of Daphnids.‖—Prof. A. Weismann and Mr. C. Ischikawa formally apply the term of paracopulation to the processes of which they have already given some account. These processes consist essentially in the presence in the egg of a cell other than the sperm-cell, which at first takes no share in the formation of the embryo, but in an early stage of cleavage unites with one of the cleavage-cells in such a way that we are compelled to speak of copulation of the

* Journ. Linn. Soc., xx. (1889) pp. 400–6 (1 pl.).
† Liverpool, n.d., 8vo, 19 pp.; reprint from 'Research,' Feb. 1890.
‡ Boll. Soc. Nat. Napoli, iii. (1889) pp. 169–268 (1 pl.). § T. c., pp. 269–72.
‖ Zool. Jahrb., iv. (1889) pp. 155–96 (7 pls.).

two cells. As the phenomena of copulation are not the same in all the genera, it is necessary to deal with each set of observations separately; *Moina rectirostris* and *M. paradoxa; Daphnia pulex* and *D. longispina; Sida crystallina; Bythotrephes longimanus; Polyphemus oculus;* and *Leptodora hyalina* are treated of in succession.

Two series of phenomena are dealt with in this memoir, and though both are concerned with the winter-egg of the Daphnida, they have no direct connection with one another. One has to do with the history of the conversion of the germinal vesicle into the egg-nucleus, and the other with the origin and fate of the copulation-cell.

The conversion of the germinal vesicle, and the formation of the polar globules is effected in essentially the same way as in other eggs which require fertilization. This fact is more important than its determination in other groups since Daphnids are capable of parthenogenetic as well as of sexual reproduction. The law of numbers of the polar globules is confirmed. Dealing with the exceptional cases lately described by Platner and by Blochmann, the authors point out that, in both cases, the eggs are arranged for sexual development; they are capable of fertilization, to effect which their germ-plasm must be halved, or, in other words, a second polar globule must be formed.

With regard to paracopulation the facts are, shortly, these. In the winter egg (or egg requiring fertilization) of six species of Daphnida, belonging to four genera, a cell is formed in the egg-cell during the ovarial development of the egg. In the still young and yolkless egg of *Moina* a part of the nuclear substance actively passes out from the germinal vesicle into the surrounding mass of protoplasm, organizes itself into a real nucleus (paranucleus), and at the same time surrounds itself with a cell-body.

When the egg is laid the copulation-cell is quite passive. After fertilization by a sperm-cell, the process of cleavage begins and goes on through a varying number of stages; the copulation-cell moves towards one of the cleavage-cells, which are sunk in the interior of the yolk, sends out short processes, and fuses with it; first the cell-bodies and then the nuclei unite.

Though the authors discuss at some length the significance of these phenomena they are at present unable to give an explanation of them. It may, however, be supposed that we have here to do with a very general process. At any rate it would be very strange if it occurred only in Daphnids.

New Entoniscan parasitic on the Pinnotheres of Modiola.*—MM. A. Giard and J. Bonnier describe *Pinnotherion vermiforme* g. et sp. n., a parasitic crustacean which lives on a crab (*Pinnotheres*) which is itself parasitic on a Mollusc (*Modiola*). It was detected in the form of a violet-grey mass, which resembles an egg-mass of *Grapsion Cavolinii;* this was the incubatory cavity of the female. The generic and specific characters are described. Only two males, and those degraded, were found; they resemble the males of *Grapsion* and *Portunion*, but are almost entirely destitute of pigment; the spermatozoa present the

* Comptes Rendus, cix. (1889) pp. 914–6; Ann. and Mag. Nat. Hist., v. (1890) p. 124.

complex structure of those of the Thoracostraca. The embryo partly resembles that of *Grapsion* and *Portunion*, and, notwithstanding the darkness of the medium in which it is developed, it is strongly pigmented with brown and green; the eyes are large. The genus, though closely allied to *Grapsion*, may be clearly distinguished by the form of the first incubatory plate and the ovary of the female, and by the arrangement of the median ventral hooks of the male.

New and little-known Semiparasitic Copepoda.*—Prof. C. Claus treats chiefly of the Lichomolgidæ and Ascomyzontidæ. As a result of his researches he offers a revised diagnosis of the genus *Lichomolgus*, eight species of which may be certainly recognized; in addition to this a new species found on sea-anemones and called *L. Anemoniæ* is described. The genera *Sabelliphilus* and *Anthessius* are re-defined, and a new genus *Paranthessius* is described; it is known only from female forms of a new species *P. Anemoniæ*. *Pseudanthessius* g. n. (with a new species *P. gracilis*) is distinguished by the peculiarities of its gnathites, and the unjointed inner branch of its fourth pair of feet. The Lichomolgidæ appear to form a definitely limited group of the Corycæidæ, and the Notodelphyidæ, which live with Ascidians, may be regarded as closely allied to, and having a common ancestry with them. A revised definition of the group is given.

The author next deals in similar fashion with the Ascomyzontidæ, of which *Dermatomyzon* (*D. elegans* sp. n.), *Echinocheres* (*E. violaceus* and *E. minutus* spp. nn.) are new genera. A new group will, when our knowledge is more advanced, have to be made for *Calagidium vagabundum*.

Gastrodelphys.†—Dr. J. H. List has a monographic account of this perplexing genus, the anatomy of which is described in detail. He cannot agree with Graeffe in associating it with the Notodelphyidæ, and thinks it is necessary to make a special group for it which will connect the Notodelphyidæ, which have biting mouth-parts, with the Siphonostomata, of which it is a family. The species live parasitically on the gill-filaments of tubicolous worms, have a short conical suctorial proboscis provided with teeth, a pair of mandibles, no maxillæ, and two pairs of maxillipeds. Of the two pairs of antennæ the anterior have five joints, and the hinder three hooks and a stalked sucker on their terminal joint. There is a median eye. Four of the thoracic segments have rudimentary swimming feet. The matricial cavity is a fold of the fourth thoracic segment. The abdomen is short, and has a furca. In addition to *G. Clausi* of Graeffe the author describes *G. Myxicolæ* sp. n. found on *Myxicola infundibulum*.

Vermes.

Texture of Central Nervous System of Higher Worms.‡—Herr B. Haller, in his investigations into the texture of the central nervous system of the carnivorous Polychæta, made especial use of *Lepidasthenia elegans*. He finds that the mode of origin of the ventral medullary

* Arbeit. Zool. Univ. Inst. Wien (Claus), viii. (1889) pp. 327–70 (7 pls.).
† Zeitschr. f. Wiss. Zool., xlix. (1889) pp. 71–146 (4 pls.).
‡ Arbeit. Zool. Univ. Inst. Wien, viii. (1889) pp. 175–312 (5 pls.).

nerves is of the following character: there are the usual peripheral nerve-bundles, the separate fibres of which either arise directly from ganglionic cells or from the central nervous plexus, which, on its part, is formed from the processes of the ordinary ganglionic cells. Two colossal fibres are present, one of which always arises directly from a colossal ganglionic cell of the opposite side; this cell is connected with the central nervous system as well as with its fellow of the opposite side by branches which break up in the central nervous plexus. Another and larger peripheral fibre, which is a branch of a central colossal fibre, has its origin in the central nervous plexus. The author's observations on the tubicolous Polychæta were not extensive. Of the Oligochæta he gives a fuller account; each pair of nerves arises thus: in the first place the nerve has fibres from the same and from the opposite side of one and the same ganglion. It also contains fibres which arise from the preceding and the succeeding ganglia of the same half of the cord, and also fibres from the corresponding ganglia of the opposite half of the cord. In this way the very closest connection is insured between each pair of nerves and the whole ventral medulla. All the ganglionic cells in the medulla of *Lumbricus* are more or less multipolar, and this is true of even the largest cells. These last are pyriform in shape and appear to have been seen by Friedländer, who places them in connection with the median colossal fibre. The author will only remark that these cells are very large in comparison with the others, and always possess several processes. The largest of these processes is always directed upwards, while the others are very small and are lost in the nervous plexus. He is able to confirm and extend Friedländer's statements as to the peculiar chemical characters of these cells. The double mode of origin of the peripheral nerve-filaments in *Sipunculus* from the ganglionic cells on the one side, and the nerve-plexus on the other, was distinctly seen.

The result of Herr Haller's work is to show that the nerve-trunks of the Nemertinea show very archaic characters, and that the central nervous system of Annelids is, histologically, very different from that of the Vertebrata. There is ample histological evidence to support the view of Gegenbaur and Haeckel that the Annelids generally are not to be regarded as stem-forms. The Nemertinea appear, on the contrary, to be very old stem-forms, from which, on the one side, the Mollusca, and, on the other, the Annelida, Hirudinea, Arthropoda, and Vertebrata, can be derived. On these points the author enlarges somewhat.

We have only space to note some of the results regarding more minute points; Herr Haller finds a distinct basal membrane under the hypodermis which separates the latter from the perineural plexus and therefore from the neurilemma, while forming an organic whole with them both. The perineural plexus round the ventral medulla has different chemical characters from that in the brain. In the free-living Polychæta there are, within the central fibrous mass, two intercoiled but not connected plexuses; one of these is coarser and belongs to the neuroglia, while the other is much more delicate and is related to the processes of the ganglionic cells and to the peripheral nerve-fibres. The neuroglia itself consists of an outer and an inner plexus; the former is wide-meshed and surrounds the whole of the nervous parts of the brain and ventral medulla, and contains the ganglionic cells in its interspaces.

Externally to this there is in the brain an inclosing membrane which the author compares with the "Glyahülle" described by Gierke in the Vertebrata, and which may be regarded as a product of the outermost parts of the perineural neuroglial plexus. In the ventral medulla this membrane is only found in the dorsal region.

In *Lumbricus* the neuroglial envelope does not send processes into the central nervous plexus, and there is not, therefore, a neuroglial plexus in the central nervous system as there is in the free Polychæta. In *Sipunculus* there is an outer and an inner neuroglial plexus, but there is no glial plexus in the central fibrous substance; in this point the Sipunculaceæ differ from the free and resemble the tubicolous Polychæta. The wide-meshed plexus of the Nemertinea is not identical with the neuroglia of other worms, which neuroglia is merely represented by a membrane which lies between it and the ganglionic cells. In *Cerebratulus* the neuroglia is in a very primitive condition.

α. Annelida.

New Pelagic Annelids.*—Herr G. M. R. Levinsen has established a new genus *Corynocephalus* in the family Alciopidæ. The body has few segments; the head-lobe is subdisciform in front, convex above, and furnished with four leaf-like antennæ; the dorsal cirri are also leaf-like, large, and imbricate; the parapodia have no cirriform processes on their apices; the setæ are mostly simple and hair-like, mixed with some of a rougher and more rigid type; the ventral papillæ are depressed at the base of the parapodia; the segmental organs are small and somewhat dorsal. This genus includes *C. albomaculatus* sp. n. from the South Atlantic. Another new species described is *Rhynchonerella longissima*. In a new family Typhloscolecidæ Uljanin, near the Opheliidæ, the author places *Travisiopsis* g. n., with *T. lobifera* sp. n. In the new family there are two segments in front of the mouth. Of these the first has an unpaired antenna, and the second (as well as the two next segments) a single nodiform "parapodium," which is not, however, comparable with the ordinary structure known by that name. The other parapodia are disposed in a double row on each side. The nodiform "parapodia" are drawn out into leaves containing fascicles of little rods and without setæ. Simple, acicular setæ (2–3) are borne on the segments with biserial parapodia, between the dorsal and ventral series. Above the pharynx is a blind protractile proboscis. The geographical distribution of *Sagitta* is also discussed.

British Species of Pachydrilus.†—Mr. F. E. Beddard thinks that two species of *Pachydrilus* are to be found at Rum Bay. One of these, which is much larger than the other, appears to be *P. verrucosus* of Claparède, while the other does not seem to be a representative of any of the other four British species described by that author, but to be *P. nervosus* of Michaelsen; this is the only form in which the peculiar perivisceral corpuscles which are so characteristic of these worms do not appear to be present.

The present state of our knowledge regarding the male gonads and

* Spolia Atlantica, K. Danske Vid. Selsk., iii. (1885) pp. 327–44 (1 pl.).
† Proc. Roy. Phys. Soc. Edinb., x. (1889) pp. 101–6 (1 pl.).

the sperm-sacs is unsatisfactory, owing to the contradictory statements that have been made regarding them. Mr. Beddard finds that the testes are largest in individuals that are not sexually mature; in them they form a bunch of divergent finger-like processes attached to both sides of the septum; and the bunches are paired. In *P. verrucosus* there were two pairs of testes, but there may be individual variation in the number. The author agrees with Michaelsen in denying the presence of sperm-sacs, and he suggests that the large size of the testes and the stout peritoneal investment render their development unnecessary.

Pachydrilus subterraneus.*—Prof. F. Vejdovsky gives a description of this new species, which has been found both at Prague and Lille. It is about 20 mm. long, is of a bright red colour, and is almost constantly in movement in the water in which it dwells.

β. Nemathelminthes.

Respiration of Entozoic Worms.†—Herr G. Bunge, who has already shown that *Ascaris mystax*, which is found in the intestines of the cat, will live four or five days in media quite free from oxygen, has continued his investigations with other Nematodes. *A. acus*, from the pike, which has no respiratory apparatus, was found to live from four to six days, and exhibit movements in similar media.

In the ultimate respiratory processes of these animals there must be a formation of energetic reducing substances (nascent hydrogen and easily oxidizable organic matter) which unite with one atom of the oxygen-molecule, even to a greater extent than in animals which breathe oxygen. Larger varieties of *Ascaris* were also examined. *A. megalocephala* of the horse lived, however, only for two days; *A. lumbricoides* of the pig, from four to seven. The gas given off was found to be not only free from hydrogen, but from other reducing substances also.

Developmental Cycle of a Filaria of the Dog.‡—Prof. B. Grassi describes the adult form of *Filaria recondita* Grassi, a specimen of which was examined by him and also by Dr. S. Calandruccio. The specimen, the only one obtainable, was a not quite mature female, and was found rolled up but unencapsuled on the fatty tissue close to the hylus of the right kidney. It is about 3 cm. long and 178 μ broad.

It would seem that this Filaria passes through four larval stages. In the first of these it exists in the blood of the dog, from which it is sucked out by the flea (*Pulex serraticeps*). The second stage is passed in the cells of the fat-bodies, the principal change being that it increases in size very much, the general shape being retained. In the third stage it not only increases in size, but the various parts and organs become more highly differentiated. In the fourth stage it exists in the encapsuled condition, being found rolled up within the cell of the fat-bodies.

Inoculation experiments with the object of infecting dogs by means of fleas were without success. This failure is ascribed to the fact that the authors were obliged to use larvæ in the third stage of development.

* Rev. Biol. du Nord de la France, i. (1888-9) 3 pp. (sep. copy) 1 pl.
† Zeit. Physiol. Chem., xiv., pp. 318-24. See Journ. Chem. Soc., 1890, p. 274.
‡ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 18-26 (17 figs.).

They claim as the result of their observations to have shown with certainty that there exist Filariæ which are propagated normally by the intervention of blood-sucking parasites, and they call attention to the resemblance of the larvæ described by them to the Filaria found by Manson in *Culex*.

Helminthological Notes.*—Prof. M. Stossich catalogues and makes notes on fifteen parasitic worms from Croatian animals. The list includes *Distomum croaticum* Stossich, *Cosmocephalus papillosus* Molin, and *Echinorhynchus globocaudatus* Zeder.

γ. Platyhelminthes.

Anatomy of Derostoma unipunctatum.†—Herr K. Lippitsch has had an opportunity of investigating the anatomy of this Turbellarian. The cells on the surface of the integument are connected by a cementing substance, are more or less polygonal in form, and have their side-walls distinctly ribbed; these cells vary considerably in size and form. No special deposits were seen in the epithelium, save some rods which lay at the anterior end of the body. The dermomuscular tube is well developed and consists of outer circular, internal longitudinal, and other fibres, which lie between and cross the outer and inner layers. The structure of the connective tissue of the body-parenchyma is very similar to that of *Graffilla*.

The œsophageal pouch, which lies between the mouth and pharynx, is not muscular; the axis of the pharynx lies at an angle of 120° to the long axis of the body; its muscular fibres have no nuclei, and are smooth; the author describes their arrangement in detail. The pharyngeal glands have efferent ducts, which all open at the anterior end of the pharynx below the sphincter and on a kind of papilla; the orifices of all the ducts form a circle. The glands themselves are of some size, and of an elongate pyriform shape; the protoplasm of their cells is either plexiform or granular, but it cannot as yet be decided whether these represent two kinds of gland or the same gland in two different stages of its activity. The pharynx is moved by two protractors and two retractors, the former of which are much more fully developed than the latter. An œsophagus, such as has been described by various authors in different freshwater and marine Vorticidæ, could not be made out. In many cases the enteric cells were so filled with crystalloids, and often also with quite homogeneous discs, of elliptical or circular contour and with brown concretions, that the structure of the cells could not be distinctly made out. In a number of important points the gonads and their appendages appear to present essentially the same characters as in allied forms already described.

The nervous system is well developed, and consists of two ganglia, connected with one another by a strong commissure; the largest of the nerves appears to be the optic; the dorsal and ventral nerves described by Böhmig have been made out, but the former presented some difficulties; the generative nerve does not appear to be present. The author

* Glasnik hrv. nar. druztva, God. iv. (Soc. hist.-nat. Croatica), pp. 8 (1889) (2 pls.).

† Zeitschr. f. Wiss. Zool., xlix. (1889) pp. 147–67 (2 pls.).

concludes with an account of the anatomy of the excretory organs, and remarks that the crystalloids have not the pentagonal dodecahedral form described by Hallez in Mesostomida.

New Land Planarian.*—Prof. F. Vejdovsky gives the name of *Microplana humicola* to a new genus of Land Planarians which he has discovered in Bohemia. One of its chief characters is the absence of the auricular appendages which are so common on the anterior part of the body in most of the Dendrocœla indigenous to that country. However much it may be contracted, its anterior part always remains rounded, as in rhabdocœlous Turbellaria. It is quite transparent, but less so when young than when adult, owing to the former retaining in their intestine the débris of vitelline cells. The animal is ciliated on the ventral surface only, and the cilia are very short; in this point it resembles *Geodesmus*, as described by Moseley. The cuticle is very fine, elastic, and so resistent as to allow for some time the pressure of a cover-glass. The epidermis is of the same thickness throughout its whole extent, and the elements of which it is composed are generally filled with a clear, almost hyaline protoplasm; at the hinder end of the body some of the cells appear to be glandular. It is by the aid of the secretion produced by these glands that the animal fixes its hinder end. The secretion is of a mucous nature. The rhabdites vary in size and disposition, according to the part of the body examined. The larger rods found at the anterior end are so closely packed that it is impossible to make out the true structure of the epidermis. Their arrangement, in fact, recalls that found by Iijima in the American *Geoplana*. This conversion of the epidermis into a sort of cuirass affords support to the view that the rods are organs of sustentation which strengthen the fine and delicate skin.

The eyes are situated over the anterior lobe of each half of the cerebral ganglion; they are very small, black spots, situated below the epidermis. Young individuals have no lateral diverticula to their stomach; and these only appear gradually. In the adult the diverticula are sharply separated from one another. The excretory organs, or pronephridia as the author calls them, belong to the second of the two types of these organs which the author recognizes; in the first, the terminal part has no vibratile flame-cells, while in the second the pronephridiostomata have such cells. In the new genus these are to be found in the peripheral region of all parts of the body; they are unicellular organs, the enlarged upper end of which is provided with a nucleus surrounded by protoplasm; the narrower part is drawn out into a fine canaliculus, the course of which could not be followed were it not for its ciliated lining. This canaliculus is formed of a series of cells set end to end, each of which has a vibratile flame, and corresponds to a pronephridiostome.

Microplana has two pairs of testes, which are rounded in form and situated between the thirteenth and fifteenth diverticula of the stomach; the animals are almost mature in September; the author is unable to speak definitely of the relation of these gonads to their ducts. The penial apparatus is pyriform and much simpler than that of *Planaria subtentaculata* or other freshwater Dendrocœla. On its outer surface the

* Rev. Biol. du Nord de la France, ii. (1889–90) 20 pp. (sep. copy) 2 pls.

muscular apparatus is invested by large, clear epithelial cells; in some examples there were seen two groups of large glands, the elements of which appear to be modified cells of the epithelial layer. At the distal extremity the epithelial cells become invaginated to form a narrow canaliculus, which is well ciliated in young individuals. This cavity swells, and so forms a kind of large space into which the constricted extremity of the seminal vesicle opens. The walls of the cavity are glandular. There are circular but no longitudinal muscles in the penis; this is a somewhat abnormal arrangement, and the author marks the differences by giving an account of the penial apparatus of *Planaria subtentaculata*. In *Microplana* some other organ is probably the copulatory, and the author thinks that the function is effected by a tubercle, the relations of which with the muscular apparatus he was, unfortunately, unable to determine. The position of the ovary and the course of the oviduct could not be made out; the cavity of the "uterus" is small, and is filled by a special hyaline liquid. In conclusion, Prof. Vejdovsky gives a review of the Dendrocœla already met with in Bohemia; five genera and eleven species have been found.

Structure of Cestoda.* —Dr. T. Pintner commences his investigation of the structure of the Cestoda by an examination of *Echinobothrium*, which appears to be a generalized type. A detailed account is given of *E. musteli* sp. n., and shorter notices of *E. typus* Van Ben., *E. affine* Dies., and *E. brachysoma* sp. n.

The nervous system appears as a large ganglion placed directly below the rostellum, and having a central cellular mass and peripheral nerve-substance, which radiates out into four short frontal trunks superiorly, and into two large primary nerves inferiorly; the two sets differ considerably from one another in their histological structure. The attaching lobes and the rostellum appear to be supplied by special nerves. The rostellum may have the form of an ellipse, the much longer main axis of which lies in the median plane, but in other stages of contraction a transverse section may be biscuit-shaped, with a similar orientation of the longer diameter. In the most anterior region it is not possible to say definitely what belongs to the rostellum and what does not; but in succeeding sections the boundary is clearly marked by a membrane with a sharp double contour.

This organ has several points in common with the rostellum of *Tænia;* it is placed in the middle of the frontal surface above the nervous system and the cephalic loops, it is made up of several systems of muscles adapted to the various relations of the head and hooks, and is connected with an apparatus of hooks. But, while the rostellum of *Tænia* is four-rayed, that of *Echinobothrium* is only two-rayed; and the same is true of the hook-apparatus. At the same time, the latter must be regarded as completely homologous with that of *Tænia*, for the hooks have exactly the same structure, being only more delicate and having much less distinct root-processes; they are arranged alternately in two layers, just like the rostellar hooks of *Tænia*. The head-stalk of *Echinobothrium* is quite round, and slightly increases in thickness from before backwards. Most externally there is a specially thick homogeneous cuticle,

* Arbeit. Zool. Inst. Univ. Wien (Claus), viii. (1889) pp. 371–420 (3 pls.).

and underneath this is the cutis, which is very indistinctly broken up into radial fibres; the internal cavity is divided by lamellar cross-sections of the root-processes of the hooks into eight sectors, and is filled by the plasmatic meshwork of the parenchyma and the nuclei of the cells that form it; in it there lie the four equal cross-sections of the water-vascular and the two cross sections of the nervous system.

A full consideration of this part of the body shows that the head-stalk is an integral part of the head.

The Echinobothria do not live boring deeply in the wall of the intestine, like other Cestoda, but rather in the looser, superficial, partly-shed epithelia of the intestine and in its mucus, where they continually perform the most lively movements. One is almost led to believe that we must correlate with this the fact that the general structure of the head does not approach the four-rayed type so closely as that of the head of *Tænia*. On the whole, *Echinobothrium* appears to be what has been called a synthetic type; by its double lobes of attachment and its head-stalk it has distinct relations to the Tetrarhynchidæ, but by its rostellum it leans to the Tæniidæ, by the generative organs (plan and form of yolk-stocks, and germ-stocks, closed uterus, and complete development of the proglottis), and partly by the hooks on its head-stalk, it is allied to the Tetrabothriidæ; at the same time it must remain in a distinct family.

Helminthological Notes.*—Sig. F. S. Monticelli separates the genus *Tetraonchus* Diesing from *Gyrodactylus* and *Dactylogyrus*, supplies a revised generic diagnosis, and describes three species. He also describes † *Tristomum uncinatum* sp. n., and a remarkable *Distomum*,‡ already named by Lopez *D. richiardii*, from the body-cavity of *Acanthias*. Its testes are numerous, and disposed in two lateral groups; the internal *receptaculum seminis* is exceedingly large; the vagina or canal of Laurer is absent; the yolk-glands which lie beside the testes are small in proportion to the size of the animal; their ducts meet in the middle of the body in a large vitelline receptacle.

Bucephalus haimeanus.§—M. Huet has a few notes on this somewhat rare parasite, which he found in *Cardium edule*. Such specimens as are infested have an unhealthy appearance, as Lacaze-Duthiers has already remarked. The lacunar tissue contains an enormous number of white filaments, which are sporocysts. In the interior of these there are *Cercariæ* in various stages of development; the author has been unable to find the œsophageal tube described by Lacaze-Duthiers. An attempt was made to follow the life-history of this parasite, but all that can yet be said is that it seems to cause the death of its host and then escapes into the surrounding water.

New Sporocyst from Cardium edule.‖—M. Huet also describes a new sporocyst from *C. edule*. It is short, spherical, or pyriform in shape, and swims freely by means of the cilia with which it is invested. Forms were found in various stages of development, and even *Cercariæ*

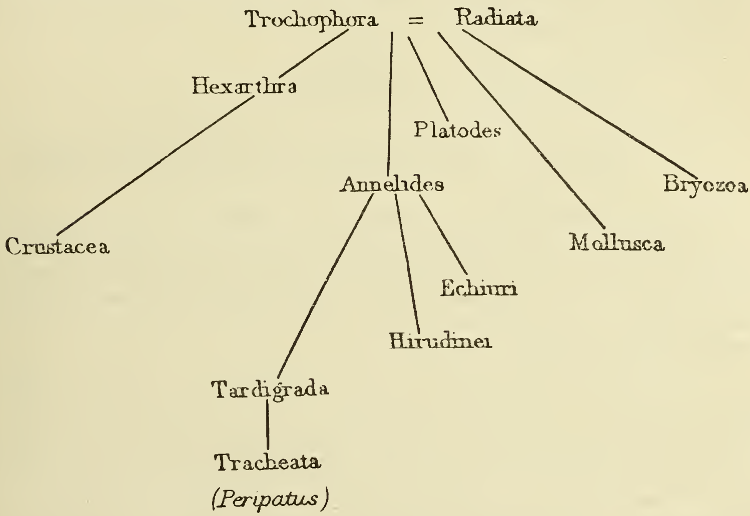
* Boll. Soc. Nat. Napoli, iii. (1889) pp. 113–6.
† T. c., pp. 117–9 (1 pl.). ‡ T. c., pp. 132–4.
§ Bull. Soc. Linn. de Normandie, ii. (1889) pp. 145–9 (1 fig.).
‖ T. c., pp. 149–51 (6 figs.).

were seen which only wanted their generative apparatus to be young *Distoma*. The author was not able to trace the parasite beyond the body-cavity of its host.

δ. Incertæ Sedis.

Rotifers of Gulf of Bothnia.*—In addition to describing the rotifer-fauna of the Gulf of Bothnia, Dr. L. H. Plate makes some observations on the anatomy of the Philodinidæ and the systematic position of the Rotifera. About a dozen species were observed, three of which—*Synchæta monopus*, *S. apus*, and *Asplanchna syringoides*—are new.

The author's views as to the systematic position of the Rotifera will be best understood from his own diagram.



Dr. Plate gives an account of his recent observations on the anatomy of *Rotifer vulgaris*, which appears to be still incompletely known. The most important points on which exact information is required are the structure of the cloaca and contractile vesicle, the question of the mode of escape of the embryos, and the structural arrangements of the peripheral nervous system. The two lateral water-vessels open into the bladder, at its anterior and ventral margin, in a way which has not been observed as yet in any other Rotifer. The two canals unite to form a glandular body, which has the same structure as the enlargement formed by each water-vessel in the anterior end of the body; a finely and closely granulated mass of protoplasm is traversed by a wall-less lumen which forms coils within it. It is possible that this common tract of the excretory canals in *Rotifer* has been already seen by other observers, and regarded by them as being a vesicle in a state of systole.

The cord which extends from the hinder end of the gonad is either connective or muscular tissue, but it is not a rudimentary oviduct; it

* Zeitschr. f. Wiss. Zool., xlix. (1889) pp. 1–41 (1 pl.).

forms a quite solid cord, the homogeneous protoplasm of which is not rarely filled by a more or less large number of granules; nuclei may be assumed to be present, though they were not seen. The cord is extraordinarily contractile. It appears to be attached to the sides of the hind-gut, at about the end of its anterior third. There does not seem to be even a very thin-walled uterus, for the embryos are seen to move about in the body-cavity. Shortly before birth the proboscis of the embryo appears to be feeling about in all the tegumentary region surrounding the anus. When it has found the anal cleft it seems to feel that there is here no great resistance to its pressure, and the embryo forcibly breaks through the hindermost part of the cloaca, and reaches the exterior through the anus.

Herr Plate thinks that there are three natural groups of Rotifers, which may be arranged thus:—

I. Digononta; with paired gonads.
  (1) Philodinidæ (= Aductifera);
  (2) Seisonidæ.

II. Monogononta; gonads unpaired. These may be arranged in families on the classification proposed by Messrs. Hudson and Gosse.

Anatomy of Stephanoceros Eichhornii.*—Mr. R. Vallentin remarks that, although this Rotifer has been known to exist for nearly one hundred and thirty years, much still remains to be learnt concerning its anatomy. He has tried to determine some of the disputed points by means of serial sections, and states that his results, though good, leave considerable room for improvement.

The tube appears to be formed from mucous cells. There are four pairs of muscles, which terminate anteriorly in a sphincter; when a living specimen retracts, the bases of the arms are brought together by the contraction of this muscle, and the longitudinal muscles being almost simultaneously brought into play, the animal retreats rapidly into its tube. The "brain" is a somewhat cylindrical organ, the walls of which are composed of irregularly shaped oval cells; each cell is wholly or partially filled with granular protoplasm, and as the secretion present in the central space is also granular, it may fairly be assumed that the granules originated from the cells and that the cells were in an active state at the time of the death of the animal. The protrusile tongue or taster, described by Dr. Hudson as connected with this organ, is considered to be a duct, while the "brain" is a salivary organ.

The true nervous elements appear to be the large, oval, nucleated cells which are placed close to the cuticle on either side of the collar; these have a marked resemblance to unipolar ganglion cells. What are generally regarded as eyes are of a chitinous nature and have a central opaque mass; their function is unknown, but it may be safely assumed that it is not visual.

Owing to the large size of the embryos and the comparative smallness of the cloacal opening, Mr. Vallentin thinks that the embryos are liberated by the death of the parent. In one series of sections an ovum was seen that had formed a gastrula by epiboly.

* Ann. and Mag. Nat. Hist., vi. (1890) pp. 1–11 (2 pls.).

New and little-known Rotifers.*—In continuation of his previous notes Dr. W. B. Burn gives, first, a description of *Furcularia tenuiseta* found in a pool at Tooting Common; it is one-fortieth of an inch long; the body has a loose glassy integument which is extremely flexible. Though delicate in appearance it burrows through dense flocculent masses with ease, for the purpose of hiding itself in the dark. He adds some notes to Mr. Gosse's account of *Diplois propatula* which was found in a pool on Esher Common, where many rare rotifers are to be taken.

The Gastrotricha.†—Dr. C. Zelinka monographs the enigmatical Gastrotricha. His diagnosis is as follows:—There is no retractile wheel-apparatus at the anterior end; there are two ciliated bands along the entire ventral surface; two coiled water-vascular canals, each bearing long rod-like ciliated lobes, open separately in the middle of the ventral surface; a simple brain-ganglion lies in part still within the ectoderm; the muscle-cells are simple; the ovaries are paired; the fore-gut is muscular, without jaw-apparatus, and like that of Nematodes; the mid-gut is straight and without glands; the hind-gut is pear-shaped, with a rectum and dorsal anus; there is a primary body-cavity.

After a discussion of the numerous opinions as to the systematic position of the Gastrotricha, Dr. Zelinka concludes that they have diverged from the ancestral line of the Rotatoria, and that they have developed parallel to the latter, but at a lower level. From the ancestors of Gastrotricha, *Echinoderes* and the Nematodes may also have arisen, but the Gastrotricha are further from *Echinoderes* than from the Rotifers. As the nearest descendants of the Trochophora, they may be ranked as Trochelminthes, among the Protonephridozoa, and before the Rotifers.

The size of these organisms varies on either side of the limit of naked-eye vision. Many are about 0·2 mm. in length, while *Chætonotus schultzei* measures 0·4 mm., and dwarf forms as little as 0·07 mm. They feed on small plants and animals, or on their remains. They swim by means of the two ventral bands of cilia, unlike Infusorians in never going backwards. One form, *Dasydytes saltitans* Stokes, is able to jump forcibly forwards by the aid of four long bristles on the ventral surface. They seem to occur in all fresh-water basins, especially in those with such aquatic plants as duckweed, *Potamogeton*, and Characeæ, most abundantly in sunny ponds, but not in rapidly flowing water.

The different forms of Gastrotricha are classified as follows:—

I. Sub-order. Euichthydina, with a forked tail.
  1. Family. Ichthydidæ, without spines.
    Ichthydium Ehrbg., 2 sp.
    Lepidoderma n.g., 4 sp.
  2. Family. Chætonotidæ, with spines.
    Chætonotus Ehrbg., 18 sp.
    Chætura Metschn., 1 sp.

II. Sub-order. Apodina, without a forked tail.
    Dasydytes Gosse, 3 sp.
    Gossea n. g., 8 sp.

* Science-Gossip, 1890, pp. 34–6 (4 figs.).
† Zeitschr. f. Wiss. Zool., xlix. (1889) pp. 209–384 (5 pls. and 10 figs.).

Dr. Zelinka has discovered the true ovaries, which lie close to the ventral and lateral wall of the beginning of the hind-gut. The mature ovum is relatively of enormous size, occupying a large part of the body-cavity, and crushing the gut and the other ova to the side. The mode of expulsion remains obscure. Like other observers, Zelinka failed to discover the summer-ova described by Metschnikoff. The laid eggs are ellipsoidal; the embryo lies bent within the shell, and when mature bursts it by main force. The sexes are probably united, but the organ described by Ludwig as testis cannot be certainly regarded as such.

Echinodermata.

Ludwig's Echinodermata.*—Prof. H. Ludwig continues and concludes his account of the water-vascular system of Holothurians; he points out that the contents of the vessels are in no way identical with water, and that they contain a small admixture of coagulable albuminoid materials; in a few cases the fluid is coloured, and cells are to be found in it. The digestive organs are next considered under the heads of (1) mouth and oral region; (2) anus and anal region; (3) divisions of the enteric tube and its macroscopical structure; (4) histology of the tube; (5) the course of the tube in the body-cavity; this is rendered more intelligible than it is often found by the aid of three explanatory diagrams; and (6) attachments of the enteron. The arborescent gills are next described; the presence of more than two trees is merely due to the basal separation of a stronger branch; an account is given of the minute structure of these organs. The part before us concludes with the early pages of the description of the interesting Cuvierian organs.

Revision of Genera and Great Groups of Echinoidea.†—Prof. P. Martin Duncan has performed a very useful work in revising the genera and great groups, fossil as well as recent, of Echinoidea. Six divisions, two hundred and fifty-five genera, and fifty subgenera are recognized; of these twelve genera and seven subgenera are new. One hundred and eight genera are regarded as synonymous with recognized types and abolished, and forty-two are made subgenera. Two subclasses are formed—that of the Palæechinoidea, all the members of which are extinct, contains four orders—the Bothriocidaroida, the Perischoechinoida, the Plesiocidaroida, and the Cystocidaroida; the two last are represented respectively by *Tiarechinus* and *Echinocystites;* the Euechinoidea contains five orders, the Cidaroida, the Diadematoida, the Holectypoida, the Clypeastroida, and the Spatangoida. The Diadematoida are divided into those with flexible and those with firm tests; the former, or Streptosomata, contains the single family Echinothuri[i]dæ, with the two subfamilies Pelanechinæ and Echinothuri[i]næ, but in an addendum, the author expresses his opinion that Prof. Jeffrey Bell's account of the characters of *Phormosoma* requires the formation of a new subfamily for that genus, as distinguished from *Asthenosoma;* the second suborder, that of the Stereosomata, contains a large number of families and subfamilies, *Salenia*, *Diadema*, *Arbacia*, *Temnopleurus*, *Echinometra*,

* Bronn's Klassen u. Ordnungen, ii. 3, Echinodermata, 1889, pp. 129–76 (pls. vi.–viii.).

† Journ. Linn. Soc., xxiii. (1889) pp. 1-311.

and *Echinus* being all included. The Spatangoida contain the two sub-orders of Cassiduloidea, and Spatangoidea. A useful explanation of the terms used is appended to the paper.

Cœlenterata.

Development of the Septa in Pteroides.*—Herr G. von Koch describes two stages in the development of *Pteroides spinulosus.* The longitudinal septum arises from the central fusion of the most oral pair of radial parietes. They cease to lie radially, and come to lie in a straight line. The cells of the septum probably originate from the endoderm, but the relation of septum to œsophagus admits of their ectodermic origin. The cavity of the larva is divided by the septum into two portions, of which one corresponds to the single interparietal space between the two radials above mentioned, and the other to the remaining seven interparietal spaces.

Arrangement of Mesenterial Septa in Peachia hastata.†—M. L. Faurot finds that there are ten distinct pairs of mesenterial septa in *Peachia hastata.* Twelve of these are large, of equal size, and set round the œsophagus; eight are very small and not fixed to the œsophagus, and there are, also, two pairs of directive septa. Below the œsophagus the septa may be divided into three groups, which differ in size and in their relations to the generative organs; in those of the first and second size the organs appear at the same level, a little below the œsophagus; with the exception, however, of the directive septa where the organs are only developed below the unpaired organ. The septa of the third or smallest size are sterile for their whole extent.

Occurrence of Ctenophores throughout the year.‡—Prof. W. C. M'Intosh brings forward evidence to show that Ctenophores may be obtained throughout the year. L. Agassiz considered that they were generally annual animals, laying their ova in the autumn and then dying—the young brood making its appearance in the spring. On the eastern coast of Scotland the most abundant Ctenophore is *Pleurobrachia*, and the presence of small as well as large examples shows that the ranks are being gradually recruited, as well as by-and-by supplanted, by the younger forms. *Pleurobrachia* seems to spawn in summer and attains a maximum size the following year, the adults gradually disappearing after shedding their ova; at no period, however, is the water devoid of them, and throughout the greater part of the year small forms are mingled with the larger. *Beroë* is seldom absent. *Lesueuria*, also, is to be found in greater or less abundance throughout the year, being another species whose spawning-period appears to be of extended duration.

Eleutheria.§—Dr. C. Hartlaub has rediscovered the species of *Eleutheria* which Claparède described some thirty years ago, and which differed essentially from those described by other authors; he proposes to call it *E. claparedii.* From the account now given it is clear that this

* Morphol. Jahrb., xv. (1889) pp. 646–9 (1 fig.).
† Comptes Rendus, cx. (1890) pp. 52–4.
‡ Ann. and Mag. Nat. Hist., v. (1890) pp. 43–7.
§ Zool. Anzeig., xii. (1889) pp. 665–71.

form is quite different from the other species of the genus. It is much larger than *E. dichotoma*, and has a much larger number of tentacles, of which there may be as many as fourteen. The tentacles are characteristic in form, for they are very long and only divide at the end; their number is always greater than that of the radial canals, and the two structures have no regular topographical relation to one another. The most interesting point in *E. claparedii* is the example it affords of the change of function of an organ; its rudimentary bell which has ceased to serve as a swimming organ has taken on a new function, for it shuts off a space into which the young Medusæ enter, and where they, protected from injuries of all kinds, pass through an undisturbed development. Dr. Hartlaub gives the specific characters of this species and also of the *Eleutheria dichotoma* of Quatrefages.

Abnormal Hydromedusæ.*—Prof. W. C. M'Intosh gives an account of some abnormal, mouthless, Hydromedusæ which were obtained in St. Andrews Bay. In considering how they manage to exist he refers to Mereschkowsky's suggestion that "the Medusa can nourish itself by means of its ectoderm by absorbing the organic material dissolved in the sea-water." The remarkable tenacity of life exhibited by certain marine animals confined in pure sea-water lends some countenance to the notion. As the Hydromedusæ are generally somewhat voracious forms, it is possible that mouthless examples may, by contracting the disk, fold themselves over prey of various kinds, and thus directly absorb nourishment through the ectoderm.

Porifera.

Physiology of Sponges.†—Dr. R. von Lendenfeld gives a detailed account of his experimental investigations on the physiology of Sponges. He first made a series of feeding experiments with carmine, starch, and milk, which were introduced into the sea-water in small quantities, and kept mixed with it by a constant stream of air. Fresh living sponges were put into these mixtures and removed after a time, which varied from 1½ to 36 hours; they were then prepared in various ways and afterwards cut into series of sections; by these means it was possible to follow the ingestion of the food-substances and their course in the sponge-body. The action of various poisons was next investigated. In all, 149 experiments are described.

The first result of the suspension of solid bodies, such as carmine or starch, in water, is the contraction or closure of the dermal pores; this may be regarded as a reflex movement of the sphincters at the pores. Later on, the pores widen again somewhat in consequence either of the sponge being unable to forego the stream of water for more than two or three hours, or to the fatigue and relaxation of the sphincters. The soft milk spheres, which may be regarded as fluid, do not usually affect the sphincters so powerfully as the grains, and there is, consequently, no reflex movement to close the pores.

The results are set out in tables and are critically considered; their study leads the author to conclude that:—

(1) The ingestion of nutriment goes on in the interior of the sponge

* Ann. and Mag. Nat. Hist., v. (1890) pp. 40–3.
† Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 406–700 (15 pls.).

and not at its outer surface, for neither carmine nor milk-globules remain attached to the outer surface of healthy sponges, and the stream of water has clearly the function of introducing nutriment and oxygen into the interior of the sponge.

(2) It is clear that the collared cells normally take up the material contained in the water that streams through.

(3) No observation supports the theory of Metschnikoff and Sollas that the collared or epithelial cells, filled with food, sink down into the intermediate layer.

(4) Carmine is only rarely found in wandering cells, and it may be supposed that such granules as are so found passed in at points of injury and not in a normal way. Dr. Lendenfeld does not believe that the collared cells give up carmine-grains to the wandering cells.

(5) With milk, however, it is otherwise; the globules are taken up by the collared cells and then passed on to the wandering cells.

The method of nutrition of Sponges may, therefore, be thus described. The moving flagella on the pavement and (?) collared cells produce a stream of water which traverses the canal system of the Sponge, so long as it is in a healthy state. Various substances are dissolved and suspended in this water. The larger suspended solid bodies do not enter the interior of the sponge, as they cannot pass through the small pores of the skin; some, however, do enter by injury of the skin, and such are sand-grains, foreign siliceous needles and the like which are used by many horny sponges in building up their skeleton. Smaller suspended particles such as arise from the decomposition of organic substances in water, as well as all substances dissolved in the water, enter the sponge, and are all, so far as is physically possible, absorbed by the flagellate cells in the chambers.

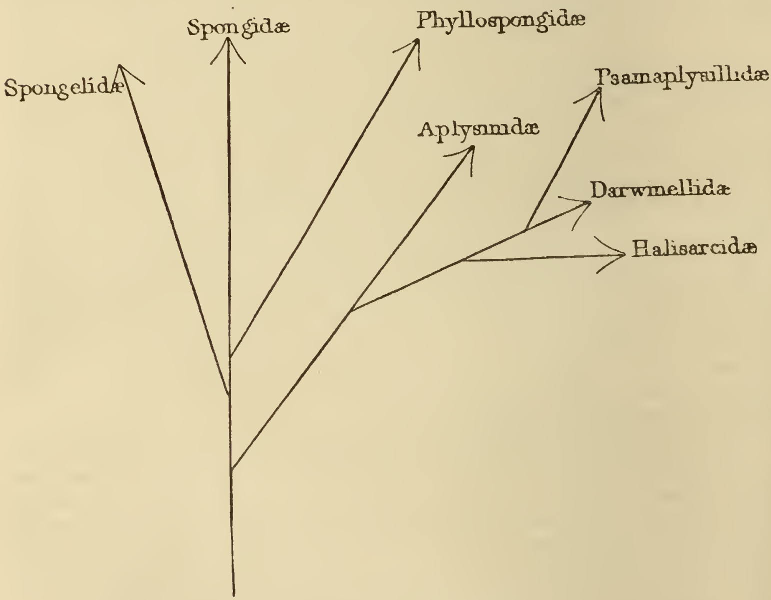
The collared cells appear at first to have no power of selection; this is effected by the skin and its pores, which keep out injurious matters; the substances taken up by the collared cells are partially digested, and pass, in a more or less assimilated state, into the cells of the intermediate layer, which acts as the means of transport for the nutrient material. The collared cells excrete what is useless in the food, while the carbonic acid formed in the tissue is probably given up by diffusion to the surrounding water.

The Sponge may be regarded as a living filter which removes from the percurrent water, by means of its collared cells, all matters useful to them. These cells, in siliceous sponges, have the property of retaining the siliceous salts contained in the water; and calcareous salts are similarly treated by calcareous sponges. The collared cells of the Horny Sponges cannot hold back either lime or silex.

Although the author's physiological experiments have not proved the existence of a nervous system, they have made its absence more than doubtful, for the extraordinary sensitiveness of the skin speaks to the presence therein of differentiated sensory cells. The sensory and ganglionic cells are spindle-shaped or pyriform, give off one longer process to the surface, or a group of three or more. Aristotle was correct in saying that Sponges could contract; this contraction is the result of harmful influences, and is especially observed when poison is dissolved in the water in which the Sponge lives—we have here a reflex movement to

hurtful external stimuli. The pores of the skin, which always contract when the water contains poison, are most sensitive in this direction. As a rule, it is not merely the dermal pores that contract under the influence of the poisons, but also the superficial canals and chambers. Of all animals, Sponges are, physiologically, most similar to plants.

Sponge-Fauna of Red Sea.*—Dr. C. Keller gives an account of the Sponges found in the Red Sea. He commences with the Keratosa, and gives a description of the horny skeleton and of the general and minute organization of these forms. In discussing systematic questions he gives the following table, which will explain itself:—



Full details as to the characters of these groups are appended.

The Monactinellidæ are next considered, and are divided into the two suborders of the Oligosilicina and the Oligoceratina ; the former have distinct spongin-fibres, which are either connected together in retiform fashion or are arborescent ; monaxial siliceous spicules are inclosed in these fibres, and vary in quantity. Free flesh-spicules may also be present. In the Oligoceratina the spongin-substance is rare, and there are no distinct fibres ; the spicules are connected by spongin or lie freely in the mesoderm. The classification given by Messrs. Ridley and Dendy in their 'Challenger' Report is regarded as the most complete yet made, although it does not in all respects correspond to the true genetic classification. The author again gives a phylogenetic table illustrative of his own views, and an account of genera and species. Of the latter a number are new.

* Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 34–405 (6 pls.).

Metamorphosis of Sponge-Larva.*—Dr. G. C. J. Vosmaer has a short account of the metamorphosis of a species of sponge, which probably belongs to the genus *Myxilla*. The free larva has an inner mass of cells of various kinds, covered all over by cylindrical epithelium. The latter soon exhibits two very distinct portions, one-seventh to one-eighth of the circumference having non-ciliated cells, which are more or less cubical in form, while the ciliated cells are very slender. There is no indication whatever as to what germinal layer the cells belong. In the central mass are a number of silicoblasts. After one or two days the freely-swimming larva becomes fixed. The point of fixation is at first in the region of the cubical cells, and the gland-cells of that region are active. The base of attachment gradually becomes larger; the flagella disappear and gland-cells become developed. The larval epithelium does not disappear, but is simply modified cell by cell. The gland-cells which, in the larva, helped to fix the animal, secrete, in the adult, the slimy substance which covers the whole surface and is characteristic of *Myxilla* and some other sponges. The subdermal cavities begin as fissures, which gradually become wider. A little later, other canals and the flagellated chambers appear in the same way.

Protozoa.

The Genus Conchophthirus.†—Dr. A. Schuberg describes *Conchophthirus anodontæ* Stein, and *C. steenstrupii* Stein, which he maintains to be the only known species of the above genus. The peristome of Heterotricha and Hypotricha had its origin in a non-ciliated groove extending from the anterior end to the mouth, and bordered laterally by undulatory membranes or the adoral zone. The absence of the adoral zone, and the author's interpretation of the secondary "pre-oral groove" (not a "peristome" *sens. strict.*) in *Conchophthirus*, lead him to remove the genus from the family Plagiotomina, and indeed from the group Heterotricha, to a position within Bütschli's family Isotrichina. Schuberg is inclined to regard the "pre-oral groove" of *Conchophthirus* as homologous with the so-called "gullet" of Isotricha.

Notes on Heliozoa.‡—M. E. Penard has found Wiesbaden a locality very rich both in species and individuals of Heliozoa. The skeletal mucilaginous zone of Acanthocystids is perfectly active, and behaves physiologically like the vacuolated ectosarc of *Actinophrys*, and the author is inclined to regard it as the true ectosarc. The skeleton may be well studied in the large *Acanthocystis turfacea* Carter; it is composed of three forms of skeletal elements—some of them are thick, very short, tangential scales which are so arranged as to give the appearance of a continuous membrane; others are large radial spicules, which are nearly as long as the diameter of the animal itself, and yet others are smaller radial spicules, which are exceedingly fine and are intercalated among the larger spicules. From his study of the constitution of these bodies the author concludes that the spicules of *Acanthocystis* are clothed with a mucilaginous varnish, within which they are formed;

* Tijdschr. Nederl. Dierk. Ver., ii. (1889) pp. 287–9.
† Arbeit. Zool.-Zoot. Inst. Würzburg (Semper), ix. (1889) pp. 65–88 (1 pl.).
‡ Arch. Sci. Phys. et Nat., xxii. (1889) pp. 523–39.

they grow simultaneously at base and apex. *Ac. albida* appears to take three months at least to arrive at the adult stage.

M. Penard's independent observations on the pseudopodia appear to confirm Hertwig and Lesser's description of a Heliozoon as "rolling after the fashion of a ball, and by the contraction of the pseudopodia."

The food of the Heliozoa appears to vary with the medium in which they find themselves, but they prefer an animal to a vegetable diet. An interesting new form, of small size (15 μ) and reddish tint, is briefly described; the ectosarc, a thin light band, is traversed by a line of very small tangential spicules, but none radial in direction; the pseudopodia are hyaline, excessively long, and not numerous; it is by their means that the animal runs like a spider, leaping to one side or straight forwards with surprising agility, so that it progresses almost as rapidly as a Flagellate. It is a true Heliozoon, which resembles some *Amœbæ* in the plasticity of its body, and in the character and small number of its pseudopodia. A new form of true Monad is also described as having filiform rigid pseudopodia similar to those of Acanthocystids, by means of which the animal attaches itself to the ground and moves slowly; it can feed equally by the whole of its surface, and is, on the whole, a Flagellate with some well-marked Heliozoic characters.

Anatomical Peculiarity of a Vampyrella.*—Herr W. Wahrlich describes a peculiar anatomical structure in a *Vampyrella*, which he believes to be unique. In its amœba-condition the *Vampyrella* is indistinguishable from *V. vorax* Cnk., but in the encysted condition presents the remarkable peculiarity of the digestive vacuole being surrounded by a cellulose-membrane. When it has fully passed from the amœba to the encysted condition, a large central vacuole is discernible in the interior of the protoplasm which has taken up all the food-material, the original small vacuoles having gradually disappeared. When treated with alcohol, a distinct membrane could be detected surrounding this vacuole, which showed with chlor-zinc-iodide the characteristic reaction of cellulose. It follows that the digestion of the food can only be effected by an enzyme which dissolves the protein-substances, and these must then pass by diffusion through the membrane. The formation of this membrane seems to be constant in the *Vampyrella* examined; but as the peculiarity appears to have a physiological rather than a morphological value, the author proposes to treat it merely as a variety under the name *Vampyrella vorax* Cnk. var. *dialysatrix*.

Spores of Myxosporidia.†—M. P. Thélohan finds that the spore of the Myxosporidia contains a small mass of protoplasm in which is differentiated a vesicle filled with a special substance, which resists colouring matters. There are present, moreover, nuclei which result from the division of a primitive nucleus; the number of these varies in different forms of Psorosperms. The author is as yet unable to point out the significance of these facts, but it is certain that the appearance of the plasmic mass of these spores of Myxosporidia, with the vesicle that refuses to stain and the nuclei scattered in the protoplasm, recalls in a striking way certain phases in the development of the spores of

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 277–9 (1 pl.).

† Comptes Rendus, cix. (1889) pp. 919–22.

Gregarines. A study of the development of these organisms will, the author hopes, afford a solution to the problems presented.

Classification of Gregarines.*—Dr. P. Mingazzini describes *Didymophyes gigantea*, one of the two species for which Stein established the family Didymophyideæ. This family was excluded by Schneider, Balbiani, and others, under the impression that the three segments were merely the result of the union of two individuals. Bütschli ignores the family altogether. Mingazzini, however, has studied the above species in the mesenteron of the larvæ of *Oryctes* and *Phyllognathus*, and believes that it represents the highest morphological grade among Gregarines. There are indeed two individuals in a sense, but the union has become intimate, and the posterior individual is virtually a sac-like segment of the anterior portion. His classification is therefore as follows:—

A. *Monocystideæ*, with a single unicellular segment; the individuals are separate, or united (in "apposition") by similar ends.

B. *Polycystideæ*, with two segments, of which the anterior bears a head; the individuals are separate, or united (in "opposition") by dissimilar ends.

C. *Didymophyideæ*, with three segments, of which the foremost bears a head; the individual is the result of intimate conjugation by "opposition."

Monads in the Blood in Influenza.†—Prof. Klebs, of Zurich, gives the results of his examination of the blood in cases of influenza. He finds a large number of highly refractile, mobile bodies, in size, form, and motility resembling bodies which he has met with in pernicious anæmia, but in far less quantity. No microcytes, such as occur in the latter disease, were to be seen. In a fatal case of influenza some blood was removed from the heart, with every precaution to avoid contamination, and the "monads" were detected therein; they varied somewhat in size, being oval in shape, and not only had vibratory movement, but were also capable of locomotion. They were often attached to the margin or imbedded in the substance of the blood-corpuscles. The organisms were distinctly flagellated, and in stained preparations their intimate connection with the corpuscles could be plainly shown. Provisionally, Prof. Klebs would assign them a place among the Rhizomastigina of the Monadineæ, according to Bütschli's classification of these protozoic forms. The Professor remarks that in other diseases in which similar Hæmatozoa have been discovered, as ague and pernicious anæmia, there is a tendency to intermittency in the type of fever; and since influenza shows a like tendency—commonly styled relapse—he thinks it quite possible that such "relapse" is associated with stages in the development of the micro-organism. The pandemic spread of influenza is analogous to that of some forms of malaria, and this is quite conceivable when one recalls the atmospheric effects which ensued after the volcanic eruption of Krakatoa. Prof. Klebs suggests that much light might be obtained by analysis of the air during the prevalence of influenza on the method of Miquel.

* Atti R. Accad. Lincei—Rend., v. (1889) pp. 234–9 (3 figs.).
† English Mechanic, 1890, p. 525.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.

(1) Cell-structure and Protoplasm.

Nuclear Origin of Protoplasm.*—M. C. Degagny now discusses the nuclear origin of protoplasm, and also the origin of diastases in the digestion of the nucellus. The facts which have been observed in the nucleus of the mother-cell of the embryo-sac of the fritillary and lily, and in the mother-cells of pollen, are only an exaggeration of a general phenomenon, the production of hyaloplasm in the interior of the nucleus. This production is clearly shown in the nucleus of the mother-cell of the fritillary by this interesting circumstance, that the hyaloplasm produced in excess and eliminated from the side of the funicular bundle coagulates on the wall of the nucleus as a substance which leaves a residue on a filter. In the embryo-sac of *Helleborus niger* (the Christmas rose) the difference is remarkable in the quantity of the products of reabsorption not used up in the sac; the appearance of the products of reabsorption coinciding exactly with the cessation of assimilation in the embryo-sac. All the evidence goes to show that the diastases arise as the result of the disorganization of the parietal cells of the embryo-sac.

Behaviour of the Nucleus in the lower Plants.†—M. P. A. Dangeard has determined by observation that in the lowest plants in which sexual reproduction takes place, the act consists in a fusion of the nuclei of the male and female cells, whether the male and female elements possess only a single nucleus, as in *Synchytrium Taraxaci*, or several, as in *Ancylistes Closterii*. The same result was obtained in *Vampyrella*.

(2) Other Cell-contents (including Secretions).

Calcium phosphate in Sphærocrystals.‡—Herr A. Hansen suggests that the purpose of calcium phosphate in the vital phenomena of plants, may be to render albumin and globulin soluble in water. The formation of sphærocrystals appears not to depend on a simple separation of the salt, but to be a result of the decomposition of protoplasm.

Colouring matter of the Integument.§—In continuation of the observations of Schimper and Courchet on the colouring-matters of flowers and ripe fruits, M. L. Claudel has made a series of similar observations on the nature of the pigments of the sporoderm (integument of the seed), in a number of Angiosperms belonging to many different orders. He finds that these pigments may either impregnate the cell-walls or fill the cell-cavity; and these latter again may be either solid substances or may be in solution in the cell-sap. In the

* Bull. Soc. Bot. France, xxxvi. (1889) pp. 346–54. Cf. this Journal, 1889, p. 239.

† Comptes Rendus, cix. (1889) pp. 202–4.

‡ Flora, xlvii. (1889) pp. 408–14. Cf. this Journal, 1889, p. 773.

§ Comptes Rendus, cix. (1889) pp. 238–41.

last case they differ from the corresponding colouring-matters of flowers and of fruits in being always derived directly from the protoplasm, and not from free-existing chlorophyllous leucites.

(3) Structure of Tissues.

Aerenchyme.*—Dr. H. Schenck describes the structure of a tissue to which he gives this name, especially characteristic of the submerged portions of aquatic and marsh plants, and particularly of those which are woody, herbaceous species being frequently destitute of it. It springs from the phellogen, and is therefore homologous in its origin with cork; it may be replaced by lenticels. Its cells are always thin-walled and not suberized, developing between them large intercellular spaces communicating with one another and filled with air; the cells themselves have an extremely thin parietal layer of protoplasm, and contain a small nucleus and minute leucoplasts, which sometimes develope into starch-grains, and a watery sap, but do not themselves contain air. In one type of structure these cells are elongated in a radial direction, and not arranged in regular zones; in a second type they form concentric strata, each composed of a single layer of cells, and connected with one another by radial trabecules. The air inclosed in the intercellular spaces contains a smaller proportion of oxygen than that of the atmosphere.

The author finds aerenchyme in species of Onagraceæ, Lythraceæ, Melastomaceæ, Hypericaceæ, Labiatæ, Euphorbiaceæ, Mimoseæ, and Papilionaceæ. Its function appears to be to facilitate the respiration of the parts of the plant in which it is found.

Structure of Dicotyledonous Stems.†—Dr. R. Raimann points out the existence of two types of structure in dicotyledonous stems. The first and simpler type occurs in most herbaceous and annual plants, and in a few woody stems, such as *Aristolochia*, *Clematis*, and *Atragene*. The increase in thickness here proceeds entirely from the cambium, which, being formed between the xylem and phloëm of the separate bundle-traces, gradually extends to the medullary rays, and thus becomes a closed thickening-ring, a portion of which in each new period of growth, as fascicular cambium, produces phloëm and xylem, while a portion, as interfascicular cambium, gives rise to the elements of the medullary rays, so that the bundle-traces have a separate course even in older stems. In the majority of dicotyledonous woody plants we find, however, a second and more complicated type. The leaf-trace-bundles do not here anastomose, as in the first type, but have blind endings in the stem; and, furthermore, the structure of the leaf-traces is different in different parts of the stem; while the leaf-traces of the upper leaves correspond in structure to the fascicular cambium, those of the lower leaves pass over into that of the interfascicular cambium. The interfascicular cambium is, therefore, not, as generally described, an exclusively cauline tissue.

Periderm.‡—M. H. Douliot has investigated the structure and origin of the periderm in plants belonging to a large number of natural orders,

* Jahrb, f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 526–74 (6 pls.).
† SB. K. K. Zool.-Bot. Gesell. Wien, xxxix. (1889) pp. 52–6.
‡ Ann. Sci. Nat. (Bot.), x. (1889) pp. 325–95 (64 figs.). Cf. this Journal, 1889, p. 406.

the present paper being devoted to the stem of Dicotyledons. The following are his general conclusions.

The origin of the periderm may vary in the three following ways: it may be hypodermal, epidermal, or pericyclic. As a general rule it may be said to originate in the pericycle. It is both a protective tissue and a reservoir for food-materials. The central cylinder is always surrounded by a continuous ring of pericyclic fibres, and this ring is sometimes separated from the endoderm by a layer of cells, and the periderm then originates outside this layer. In the pericycle the periderm may either be in contact with the endoderm, or may be mingled with the fibres, or may spring from below the fibres; it is always outside the liber, and therefore outside the outermost sieve-tubes.

The position of the periderm is of but little value for purposes of classification; it may be characteristic of an order, tribe, genus, or species. It is more developed in parts exposed to light than in the shade. The cortex disappears only to serve as food-material for the deeper tissues. The foldings on the radial walls of the cells, hitherto considered as characteristic of the endoderm, may belong to a secondary formation.

Thickening-ring of Bark.*—Herr M. Koeppen discusses the activity of the bark of our dicotyledonous trees during the period of activity of the thickening-ring. The passage from wood to bark is formed by a layer in which the new tissue-elements of both wood and bark arise. This is termed the thickening-ring, and consists of three zones:—the outermost comprises the young cells of the bark, the innermost the young wood-cells, while between them lies the true cambium. The chief purpose of the cortex is the conduction and storing-up of the substances which undergo metastasis in the green parts of the plant, though new substances are also formed in it.

In the mode of growth of the secondary bark two types may be distinguished:—that of *Tilia*, in which the increase of girth is limited to the primary medullary rays, and that of *Quercus*, where the medullary rays usually consist permanently of one row of cells only, growth taking place in the rest of the parenchyme through the force of tangential traction. In the periderm are to be found cells which have more than doubled their length in the tangential direction without their walls having increased in thickness; and these cells always contain living protoplasm during the period of their increase in size. Beneath the epiderm there is often formed, for additional support, in the midst of the primary parenchyme, a ring of bast-cells and sclerenchyme-cells.

Free Vascular Bundles in Olyra.†—In a large Brazilian grass belonging to the genus *Olyra* Dr. F. Müller finds that the cylindrical cavity of the hollow haulm is frequently occupied by spiral or twisted perfectly free vascular bundles, which frequently coalesce with one another or with the wall of the cylinder. Their number mostly varies between one and ten, though there are sometimes over twenty, and they are seldom found in all the internodes of the same stem, as some internodes are usually entirely destitute of them. These free vascular bundles

* Nova Acta Acad. Cæs. Leop.-Carol., liii. (1889) pp. 441-96 (1 pl.).
† Flora, xlvii. (1889) pp. 414-20 (1 fig.).

appear to be confined to a single species of *Olyra*, and Dr. Müller is unable to assign to them any function in the life of the plant.

Anatomy and Histogeny of Strychnos.*—Dr. D. H. Scott and Mr. G. Brebner have endeavoured to clear up, as regards the anomalous genus *Strychnos*, some of the points which previous investigations have left obscure. The general structure of the stem, its development, and the development and structure of the phloem-islands, are all carefully described, and also the structure of the root. The authors recapitulate the results of their investigations as follows:—(1) The external phloem, though but little developed, contains sieve-tubes and companion-cells of normal structure, with the exception that nuclei are found in the mature sieve-tubes. The latter fact is perhaps an indication of their rudimentary character. (2) (*a*) The medullary phloem-groups, as shown by their development and by their course, form an integral part of the leaf-trace-bundles, which are therefore from the first of bicollateral structure. (*b*) These medullary groups grow by means of a special cambium lying on the outer side of each group. (3) (*a*) The phloem-islands, or interxylary phloem-strands, are formed centripetally by certain portions of the normal cambium. (*b*) The phloem-islands continue to grow after they are inclosed in the wood, by means of the cambium layer on their inner side. (4) The roots, in so far as they have a pith, possess medullary phloem-groups similar to, but smaller than, those of the stem, and increasing, like the latter, by means of a centrifugally active local cambium. The authors then conclude with various comparative considerations.

Floating-tissue of Nesæa verticillata.†—Mr. J. Schrenk states that *Nesæa verticillata* grows in stout clumps along the swampy borders of pools and lakes. In the months of July and August many of the slender wand-like stems sent up by the root-stock have attained considerable length, and begin to bend downward by their weight until the apex of the stem touches the surface of the water, when they curve up again. At the region of contact between stem and water a swelling will be noticed about 10 mm. below the apex. The apex continues to grow more or less rapidly, while the swelling below it increases, and extends over a distance of 20–40 cm. The epiderm of the stem at this region shows longitudinal fissures; and underneath a snow-white, soft, elastic, spongy tissue is seen, the function of which is to prevent the apex of the stem from sinking below the surface of the water and to keep the stem afloat. It consists of parenchymatous cells of peculiar shape and arrangement. The walls of these cells are very thin, and consist of cellulose; they contain a delicate lining of protoplasm, in which slow but distinct currents may be noticed, and also small rounded starch-grains.

The development of the floating-tissue is as interesting as its function, the meristem producing it being first noticed at the sides and upper part of the horizontal floating stem; and consequently at a later stage the aerenchyme ‡ is more copiously developed at those places than on the lower side where the roots grow.

* Ann. of Bot., iii. (1889) pp. 275–302 (2 pls.).

† Bull. Torrey Bot. Club, xvi. (1889) pp. 315–23 (3 pls.). Cf. this Journal, 1889, p. 779.

‡ Cf. *supra*, p. 197.

(4) Structure of Organs.

Podostemaceæ.*—In the third part of his monograph of this natural order, Prof. E. Warming describes eleven species, five of which are new. As regards the systematic position of the order, he regards it as most nearly allied to the Saxifragaceæ, with its vegetative structure modified by the habit of growing on a rocky bottom in rapidly running water. One of the most marked vegetative peculiarities of the order is the dorsiventral structure of the young shoots in all the species.

Morphology of the Lauraceæ.†—Herr C. Mez treats the morphology of this natural order from the following points:—Phyllotaxis, leaves, bud-scales, inflorescence, flowers, fruit. The dissemination of the fruits is effected largely by birds, rodents, and apes; pollination chiefly by the agency of insects.

Dichotypism.‡—Dr. M. Kronfeld distinguishes three kinds of dichotypism, viz. heteranthic, heterocarpic, and heterocormic, depending on variations in the development of the flower, the fruit, or the vegetative organs respectively. He further points out that, instead of regarding the characters of a hybrid as resulting from a combination of the characters of the parents, we should rather see in them an evidence of the polarity of the protoplasm in the germinal cell.

Stamens of Solanaceæ.§—Prof. B. D. Halsted states that in the order Solanaceæ there are three modes of the dehiscence of stamens; but that there is one character which is common to them, and limited to the order, viz. the presence of a cone or "columella" in each anther-lobe.

Development of Pollen.‖—M. L. Mangin has paid special attention to the nature of the walls of pollen-grains and their transformations. After giving the details of numerous observations, the author states that at first the membrane of the pollen-grain is homogeneous, and is formed of pure pectic compounds; soon this membrane differentiates towards the exterior, and is transformed into cutin; and a little later, internally, and in one part of its thickness it is found to consist of cellulose. Two layers can then be distinguished, the intine and extine; but these two layers must be considered as the progressive differentiation of a single membrane. The structure of the membrane of the pollen-grain presents a striking analogy to the external membrane of epidermal cells. The author obtained the best results with *Lilium candidum*, *Asparagus officinalis*, *Cephalaria tartarica*, and *Geranium pratense*.

Development of the Pollen-grains in Rosa.¶—M. F. Crépin gives details of an examination of the pollen of numerous members of the genus *Rosa*. In order to observe pollen a low-power objective only is necessary; when placed in water well-developed pollen-grains swell

* 'Familien Podostemaceæ,' Afh. 3, Copenhagen, 1888 (French résumé), 72 pp. and 12 pls.

† Verhandl. Bot. Ver. Brandenburg, xxx. (1888) pp. 1–31. See Bot. Centralbl., xl. (1889) p. 362.

‡ SB. K. K. Zool.-Bot. Gesell. Wien, xxxix. (1889) pp. 65–6.

§ Bot. Gazette, xiv. (1889) p. 260.

‖ Bull. Soc. Bot. France, xxxvi. (1889) pp. 386–93. Cf. this Journal, *ante*, p. 56.

¶ CR. Soc. Roy. Bot. Belgique, 1889, pp. 114–25.

rapidly and become spherical, while atrophied grains remain small and elliptical, or irregular in form. In the group *Synstylæ* the pollen was found to be abundant and perfect, while in the *Caninæ*, *R. canina* for example, the proportion of well-developed grains varied from one-third to two-thirds. In the groups *Carolinæ*, *Cinnamomeæ*, *Pimpinellifoliæ*, and *Sericeæ*, the pollen was generally found to be abundant and perfect.

Variations of Water in the Perianth.*—M. Emery gives the results of various experiments made to ascertain the amount of water in the perianth. The law of variations of the amount of water presents two cases for terrestrial plants, according as they grow under normal conditions or in a medium saturated with moisture. In the first case, the point of maximum imbibition corresponds with a middle phase of the life of the perianth; in the second case, the maximum point and relative weight of water increases without ceasing from the commencement of flowering to the fall of the perianth.

Extrafloral Nectaries.†—Herr F. Ludwig describes the structure of the extrafloral nectaries in a number of myrmecophilous plants, and the mode in which the ants are attracted to them. In *Impatiens balsaminea* they consist of a number of hairs containing a red pigment, closely adpressed to the stem and with their apex pointing upwards; while those which are intended as a protection against creeping insects have their apex pointing downwards. In *I. cristata* and *tricornis* the road to the dark-red extrafloral nectaries is indicated by a row of red dots, which, like the nectaries themselves, are serrations of the leaf, and sometimes also themselves develope a secretion. Even the young seedling is protected in this way from the attacks of ants. In *Sambucus racemosa*, *Viburnum Opulus*, and other plants, the nectaries themselves, attached to the leaf-stalks, are rendered conspicuous by a very bright colouring.

Tearing of the Leaves of Musaceæ.‡—Herr C. Lippitsch describes the mechanical principle on which this phenomenon, characteristic of all the families of the Scitamineæ, viz. the Musaceæ, Cannaceæ, Marantaceæ, and Zingiberaceæ, depends. He points out that this tearing inflicts no injury on the assimilating functions of the leaf, and that the plant is thereby spared any unnecessary consumption of energy in the production of strengthening tissue. The margin of the leaf is provided with small narrow wings, which serve, when young, as a reservoir for water. In older leaves these wings dry up, and it is the contraction connected with this desiccation which causes the rupture of the tissue of the leaf.

Leaves and Shoots of Euphorbiaceæ and Cactaceæ.§—Herr X. Wetterwald describes in detail the structure and development of the stem and leaves in the succulent species of *Euphorbia*, of which nineteen are named, and in several genera of Cactaceæ, viz. *Opuntia*, *Peireskia*, *Phyllocactus*, *Epiphyllum*, *Cereus*, *Echinopsis*, *Pilocereus*, *Echinocactus*, *Echinocereus*, and *Mammillaria*. In both groups there are forms with

* Bull. Soc. Bot. France, xxxvi. (1889) pp. 322–33.

† Humboldt, viii. (1889) pp. 294–7 (4 figs.). See Bot. Centralbl., xl. (1889) p. 79. Cf. this Journal, 1889, p. 543.

‡ Oesterr. Bot. Zeitschr., xxxix. (1889) pp. 206–10, 259–63 (1 fig.).

§ Nova Acta Acad. Cæs. Leop.-Carol., liii. (1889) pp. 377–440 (5 pls.).

ordinary foliage-leaves, and with rudimentary leaves; but in the Cactaceæ the suppression goes much further than in the Euphorbiaceæ. Both families are distinguished by a strong development of the base of the leaf; the spines of the Euphorbiaceæ are stipules or lateral shoots; those of the Cactaceæ are always foliar organs of the undeveloped lateral shoots. The Cactaceæ differ from the Euphorbiaceæ and from most other plants in the leaves which are in immediate proximity to the apex producing rudiments of shoots in their axes.

Glands in Echinops and Diervilla.*—Mr. T. Meehan describes the nectar-glands in *Echinops*, which is cultivated for bees, situated at the top of the corolla-tube, instead of the base, as is usually the case; and the epigynous glands of *Diervilla*, which he regards, from a comparison with those of *Lonicera*, as rudimentary branches.

Glands of Eichhornia.†—Herr V. A. Poulsen finds, in the leaf-stalk of *Eichhornia crassipes*, peculiar glands on the walls of the air chambers. Each gland has two heads which secrete an oily fluid containing a small quantity of tannin. They are formed from single cells, have a mulberry-like appearance, but are hollow and open at the apex.

Calcareous Scales and Epidermal Glands in Globularieæ and Selagineæ.‡—M. E. Heckel states that in the Globularieæ and Selagineæ calcareous epidermal glands are to be found similar to those existing in Plumbagineæ, Frankeniaceæ, and Tamariscineæ. There also exist in certain species non-calcareous epidermal glands, and these glands are peculiar to these two families. The latter are the rule within these families, while the former are the exception, being only a physiological adaptation of the calcareous glands. The two forms of gland are sometimes to be met with on the leaves of the same species (*Globularia ilicifolia*); or they may occupy different organs on the same individual, as in *Selago spuria*, where the leaves have calcareous while the stem bears non-calcareous glands.

Protuberances on the Branches of Biota.§—Herr O. Lignier has examined the peculiar warts found on the lower branches of *Biota*, and has found them to be undeveloped adventitious roots which have remained inclosed in the bark. The growing point of the root appears to be still active; around its apex is formed a phellogen, which developes phelloderm outwardly, periderm inwardly; the latter passes over gradually into the root-cap.

Floating Organs of Neptunia oleracea.‖—Dr. G. Ritter Beck v. Mannagetta describes the floating organs of this plant (*Desmanthus natans* W.) from Sumatra. All the cells of the cortical tissue are stellate, none of them round. There is no secondary cambium, nor any uninterrupted ring of bast-cells after the disappearance of the

* Bot. Gazette, xiv. (1889) pp. 258–9 (2 figs.).

† Vidensk. Meddel. Naturhist. Foren. Kjöbenhavn, 1888, p. 28 (1 pl.). See Bot. Centralbl., xxxix. (1889) p. 124.

‡ Comptes Rendus, cix. (1889) pp. 35–8.

§ Bull. Soc. Linn. Normandie, ii. (1889) pp. 118–24. See Bot. Centralbl., xl. (1889) p. 125.

‖ SB. K. K. Zool.-Bot. Gesell. Wien, xxxix. (1889) pp. 57–9.

floating organ. The spongy parenchyme of the latter is formed by the enlargement of the cortical layers, which are already present, but consist hitherto of closely packed cells. The medullary cells are stellate when young, but afterwards become rounded; among them are crystalliferous cells, which vary greatly in size.

Tubercles.*—M. A. Seignette applies the term tubercle to all those parts of the plant where an accumulation of reserve-material takes place, which is destined to aid in the perpetuation and multiplication of the plant. He treats first of tubercles formed by the stem, with few or no secondary formations; and as a good example of this may be instanced the case of *Stachys tuberifera*. In this plant the tubercles are formed by the internodes of the underground stems, and are very variable in size. They are white, and at each of the nodes which separate the swollen internodes two opposite scales are to be found. Occasionally, in certain tubercles, lateral buds give rise to new secondary tubercles, instead of a stem, and in a few days the reserve-materials which were in the original tubercle are localized in the secondary tubercles. If a transverse section be made of a tubercle it will be found to have been formed by a considerable development of the pith, accompanied by a relatively less augmentation of the cortex. The author compares *Stachys palustris* with *S. tuberifera*, and indicates many points of resemblance between these two plants.

In *Oxalis cornuta* the tubercles are produced by a development of the primary tissues of the cortex, pericycle, and pith. The reserve-material accumulated in the tubercle was found to consist of starch and glucose, with a small quantity of saccharose. In *Begonia* we find an external morphology closely resembling *Cyclamen europæum*. The tubercle of *Cyperus esculentus*, which is formed by the swelling of a large number of internodes, has a very complex structure, the material for the nourishment of the plant being accumulated in the greatly augmented cortex and pith.

The author then describes four cases in which tubercles are formed on the stem with the development of secondary formations. In *Apios tuberosa* the tubercle is constituted from the non-lignified elements of the wood, the exterior elements preserving their function of conduction, while the interior elements are transformed into reserve-tissue.

Tubercles which are formed by the roots may be classed into two groups, depending on the amount of secondary formation. In the first group, where there is little or no secondary formation, the tuberization is produced by a large development of the cortex and pith (*Ranunculus asiaticus*, *Asphodelus albus*, *Asparagus officinalis*, &c.). In the second group, where the secondary formations are much developed, nearly all the tuberization consists of secondary parenchyme (*Spiræa Filipendula*, *Campanula barbata*, *Lathyrus tuberosus*, &c.).

In *Bryonia dioica* the tubercles are formed by the swelling of the underground stem, and towards their base by the swelling of the root. In a transverse section of the upper part of a young tubercle, four primary woody bundles will usually be found arranged in a single circle.

* Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 415–29, 471–86, 509–36, 558–81, 611–29 (115 figs.).

The pericycle is much developed, and the pith much reduced ; and a cortex will be found, the cells of which are larger than those of the pericycle. The curious example of the bulbs formed by the leaves of *Oxalis Deppei* is then described, and also the case of *Anemone coronaria*, in which tubercles are formed by the swelling of the stem, root, and leaves. In the genus *Allium* also some of the flowers are frequently transformed into ovoid bulbils.

The second part of the paper deals with physiological researches on tubercles, numerous experiments having been made to show the variation occurring in the proportion of water and of dry weight.

The author concludes this portion by describing two methods employed to measure the temperature of tubercles. In the first method Thomson's galvanometer was used, and the temperature noted, and in the second, specially constructed mercurial thermometers were employed, and the tubercles perforated in order to allow the bulbs of the thermometers to be introduced.

As a summing-up, the following conclusions are drawn. Tubercles may be classified as follows according to their morphological nature:—(1) Tubercles formed by the stem. (*a*) With little or no secondary formation. (α) Dicotyledons (*Stachys tuberifera*, *Oxalis crenata*). (β) Monocotyledons (*Cyperus esculentus*, *Crocus vernus*). (*b*) With development of secondary formations (*Apios tuberosa*, *Epilobium Fleischeri*). (2) Tubercles formed by the root. (*a*) With little or no secondary formation. (α) Dicotyledons (*Ranunculus asiaticus*, *Ficaria ranunculoides*). (β) Monocotyledons (*Asphodelus albus*, *Simethis planifolia*). (*b*) With development of secondary formation (*Spiræa Filipendula*, *Campanula barbata*). (3) Tubercles formed by the stem and root (*Aquilegia vulgaris*, *Beta vulgaris*). (4) Tubercles formed by the leaves (*Oxalis Deppei*, *Tulipa*, *Lilium*). (5) Tubercles formed by the stem, leaves, and root (*Anemone coronaria*). (6) Tubercles formed by the flowers (*Allium carinatum*, *Allium vineale*, *Nothoscordum fragrans*).

As to the chemical composition of tubercles, starch, inulin, saccharose, galactane, and glucose are the substances most frequently found in reserve. As a general rule it may be laid down that the temperature of tubercles is always higher than that of the soil which incloses them. The relation of the dry weight of tubercles to their fresh weight is very variable, not only according to the species, but even according to the period of development when the weight is taken. The proportional dry weight usually reaches a maximum coincident with the period of development when the tubercle is latent.

Tubercles of Stachys tuberifera.*—M. L. Seignette states that the tubercles of *Stachys tuberifera* are formed by the swollen internodes of the underground stems. Their dimensions are variable, the longest observed being eight centimetres. The author then describes the formation of aerial stems on the tubercles, and also traces the development of the tubercles themselves. Their composition has been determined by M. A. Planta, who states that they contain 75 per cent. of galactine, a carbohydrate intermediate between starch and sugar, and discovered by Schultze in lupin seeds. Various experiments having

* Bull. Soc. Bot. France, xxxvi. (1889) pp. 189–94.

been made to ascertain the temperature of the tubercles, it has been determined that the point of maximum temperature is when the aërial stems commence to appear.

The anatomy of the aerial stem and that of the tubercle differ greatly. If the structure of the underground stem bearing the tubercle be examined, it will be found to be quadrangular, and at each of the angles a layer of collenchyme protecting a fibrovascular bundle will be seen; then a cortex fifteen to eighteen cells in thickness, and then the pith. If a transverse section be made of the first slightly swollen internode, the collenchyme will be found to be diminished, the cortex of about thirty cells in thickness, the wood diminished in quantity, and the pith greatly augmented. If a section be made at the base of the aerial stem, the collenchyme will be found greatly developed, and protecting four large fibrovascular bundles, a diminished cortex, a zone of pericyclic lignified fibres, and finally a greatly diminished pith. The tubercle is then formed by a considerable development of the pith accompanied by a relatively less augmentation of the cortex.

M. P. Maury* states that the morphological value of the tubercles of *Stachys affinis* Bge. (*S. tuberifera* Naud.) is the same as that of the potato, both being swollen subterranean stems. If a transverse section be made of an internode towards the middle, the following will be the arrangement from the periphery to the centre:—in the first place an epiderm, on the exterior of which is a thin layer of cutin; the cortex, formed of large roundish cells; then the fibrovascular zone, consisting of four principal fibrovascular bundles; and finally a very bulky pith. The difference between the structure of a tubercle and that of an aerial stem is but slight, and is principally marked by the absence of stomates and chlorophyll and the predominance of pith in the tubercle.

Non-chlorophyllous Humus-plants.†—Herr F. Johow describes the peculiarities of structure of the "holosaprophytes," or saprophytes destitute of chlorophyll, of which he enumerates 165 species belonging to 43 genera and 5 natural orders, viz. Orchidaceæ, Burmanniaceæ, Triuriaceæ, Ericaceæ, and Gentianaceæ, all the species of the two genera of Triuriaceæ belonging to this class of plants. Of these about 44 belong to Temperate, and 121 to Tropical countries. Most grow in the soil, some on rotten branches of trees, *Sciaphila* (Triuriaceæ) on the nests of termites.

The roots are generally but feebly developed, and well-developed root-hairs entirely wanting, except in *Sciaphila*. The central cylinder exhibits varying peculiarities of development. Except in *Wullschlægelia* (Orchidaceæ) the roots are always invested by a mycorhiza, which (except in *Monotropa Hypopitys*) does not penetrate beyond the epidermal cells, and affects the cells so little that they still contain protoplasm and even a nucleus. It is apparently this fungus that causes the usually coral-like or tufted appearance of the root. The author believes that the mycorhiza absorbs not only nitrogen, but also the nutrient substances resulting from the decay of the humus. In epiphytic orchids the mycorhiza is wanting in those parts which hang free. Except in

* T. c., pp. 186–9.

† Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 475–525.

Epipogium stomates are wanting on the stem. The vascular bundles are usually of simple structure. The intercellular system and strengthening tissues are but feebly developed.

All holosaprophytes have small seeds with a rudimentary unsegmented embryo; the ovules frequently do not develope into fertile seeds, showing that the structure is the result of degradation. The ovules of *Voyria* (Gentianaceæ) are destitute of integument, resembling those of *Balanophora*. The seeds of *Sciaphila* contain endosperm, and the author regards the natural order Triuriaceæ as nearly allied to Alismaceæ.

Gramineæ and Cyperaceæ.*—After describing the inflorescence of the Brazilian genus of grasses *Streptochæta*, Dr. L. Celakovsky discusses the phylogenetic connection of the orders Gramineæ and Cyperaceæ, regarding both as descended, in different lines, from the Juncaceæ, the former having departed the more widely from the ancestral form. The reduction of the number of ovules to one, and the origin of this from the base of the ovary, is a phylogenetic advance common to the two orders; the usual coalescence of the ovule with the wall of the ovary, and the formation of the scutellum in the grasses, are further steps in advance not found in the sedges. The position of the embryo in the Cyperaceæ, surrounded by the endosperm, is also more archaic than the lateral position in the Gramineæ. The same is also the case with the 2–3-carpellary pistil of the Cyperaceæ, contrasted with its 1- or 2-carpellary structure in the Gramineæ.

With regard to the inflorescence, that of grasses is usually diplocaulic (biaxial), while that of the Cyperaceæ is frequently haplocaulic (uniaxial). The inflorescence of the tribe Cariceæ of the order Cyperaceæ the author states to be indefinite; and they are therefore more nearly allied to the Scirpoideæ than to the Caricoideæ, under which they are usually placed.

β. Physiology.

(1) Reproduction and Germination.

Physiology of Reproduction.†—Dr. G. Klebs brings forward evidence in favour of the view that the mode of reproduction in the lower organisms, whether sexual or non-sexual, is largely dependent on external conditions. The experiments here described were made entirely on *Hydrodictyon utriculatum*, in which the two modes of reproduction are well known—non-sexual by means of zoospores, and sexual by means of motile gametes which conjugate to form a zygote; the cycle being generally closed by the production of a sexual succeeding a number of non-sexual generations.

Dr. Klebs finds that, by cultivating this alga in a 0·5–1 per cent. nutrient solution, composed of 1 part magnesium sulphate, 1 part potassium phosphate, 1 part potassium nitrate, and 4 parts calcium nitrate, and then bringing it into fresh water, the formation of zoospores is greatly promoted; but that it is in all cases absolutely dependent on light, which must, at least for a time, act upon the culture. It is, however,

* SB. K. Böhm. Gesell. Wiss., 1889, pp. 14–12 (1 pl.), and 9–113 (1 pl.).
† Biol. Centralbl., ix. (1889) pp. 609–17.

only the development and the escape of the zoospores which are promoted by the saline solution, their first formation being the result of the internal nature of the cell. Some organic substances, as maltose and dulcite, also promote the formation of zoospores.

The tendency to produce gametes is not so easily excited, but can be brought about by cultivation in a 7–10 per cent. solution of cane-sugar, the presence of nutrient salts being excluded; and this can take place even in the dark.

Further experiments showed that, in a single net consisting of equivalent sister-cells, some of the cells can be excited, by external conditions, to develope zoospores, others to develope gametes. In a net which is commencing to produce gametes, a change to the formation of zoospores can be brought about by immersion in the above-named saline nutrient solution; a change from the sexual to the non-sexual condition is not so easily effected, but can be brought about by cultivating in maltose or dulcite.

The general conclusion of the author is that there is not in *Hydrodictyon* any true and necessary alternation of sexual and non-sexual generations such as is displayed in the Muscineæ and Vascular Cryptogams, but that every cell of the net has the capacity for producing both kinds of organ, and that it depends on external conditions which of the two forms of reproductive organ is brought into existence; favourable conditions tending, as a rule, to the production of non-sexual, unfavourable conditions to the production of sexual organs.

Nursing of the Embryo.*—Mr. T. Johnson describes the peculiar mode of growth of the embryo in the parasitic *Myzodendron punctulatum*, belonging to the Loranthaceæ. After fertilization the secondary nucleus of the embryo-sac divides repeatedly into a row of nuclei extending the whole length of the embryo-sac, which are soon separated by cell-walls, so that the interior of the embryo-sac is occupied by a uniserial column of endosperm-cells. During this time the narrow antipodal end of the embryo-sac has elongated upwards and backwards in the body of the placenta. It then makes a sharp bend upon itself, and continues its penetrating course, in a more or less winding manner, through the free column of the placenta, and on through the tract of tissue continuous with this, until it reaches the base of the flower, where its tip dilates and becomes imbedded in the vascular cup formed by the three carpellary vascular bundles, between the tip of which and the descending tip of the embryo-sac a few layers of rich parenchymatous cells intervene. Throughout its prolongation the embryo-sac remains a uniserial column of uninucleate richly protoplasmic cells. During the same time the nucellus-portion of the embryo-sac has become filled with endosperm-cells. The embryo, although divided into a small number of cells, remains for a long time undifferentiated, as in many other parasites. The main function of the embryo-sac tube is clearly nutritive. The placenta being destitute of vascular bundles, it acts as a carrier of food from the floral vascular bundle to the developing seed. In the ripe seed it is still an open tube, though its protoplasm is reduced to a thin layer inclosing a large quantity of cell-sap.

* Ann. of Bot., iii. (1889) pp. 179–206 (2 pls.).

A similar elongation of the embryo-sac takes place in many Santalaceæ, as *Santalum*, *Osyris*, and *Thesium*, in *Groutia* among the Olacineæ, and in other Loranthaceæ.

The mode of germination resembles that in *Viscum*.

Fertilization of the Vine.*—In continuation of his previous experiments on this subject, Herr E. Ráthay gives a number of very interesting results, of which the following are some of the more important :—

If the inflorescences of the female plants of the vine are protected from xenogamy, and the impregnation is confined to autogamy or seitonogamy (impregnation by pollen from other flowers of the same inflorescence), the flowers always wither soon after expanding; but, if impregnated xenogamously by the pollen of male or hermaphrodite individuals, normal bunches of grapes are produced. The inflorescences of hermaphrodite individuals, on the other hand, develope into normal bunches by seitonogamy and autogamy, or by the latter alone, if xenogamy alone, or both xenogamy and seitonogamy, are prevented. The author confirms Delpino's observation that the hypogynous nectaries produce abundance of honey. The distance of the hermaphrodite from the female flowers makes no difference in their fertilizing power.

With regard to *Vitis vinifera*, the seedlings of wild grapes are nearly always either male or female, very rarely hermaphrodite; while those of cultivated grapes are partially hermaphrodite. Seedlings of *Vitis riparia* and of American grapes gave somewhat different results. The general conclusion drawn is that there belong properly to the grape-vine only two different kinds of individuals, one of which is purely female, the other male, hermaphrodite, or intermediate, according to the degree of development of the pistil; these two kinds differ from one another in their inflorescence as well as in their individual flowers. Barrenness of the female flowers may be caused by the cap (calyx) remaining permanently attached. Pollination may be effected either by the wind or by insects.

Sexuality of Lychnis vespertina.†—M. A. Magnin gives a detailed account of the structure of the different sexual forms of this plant, and of the deformations caused by the attacks of *Ustilago antherarum*. The male and female plants are essentially different forms, differing not only in the presence or absence of the sexual organs, but also in size (the male plants being smaller), in the venation of the calyx, &c. Hermaphrodite individuals are simply female plants in which stamens are produced by the presence of *Ustilago antherarum*. In the male plants this parasite causes only a slight deformation of the anthers, and usually mesostemony or brachystemony, while in the female plants it brings about :—(1) The production of stamens as the only organ in which its spores can develope; (2) atrophy of the style and upper part of the ovary; (3) a greater or less elongation of the internode between calyx and corolla, this being also characteristic of the male plant. It also

* 'Die Geschlechtsverhältnisse der Reben,' Theil ii., 8vo, Wien, 1889, viii. and 92 pp., 3 pls., and 8 figs. See Bot. Centralbl., xxxix. (1889) p. 380. Cf. this Journal, 1889, p. 249.

† 'Rech. sur le polymorphisme . . . de *Lychnis vespertina*,' Lyon, 1889, 30 pp., 2 pls., and 8 figs. See Bot. Centralbl., xl. (1889) p. 186. Cf. this Journal, 1889, p. 412.

causes frequently tetramery or pentamery of the flowers, lobing of the margin of the petals, and a change in the venation of the sepals. The author traces a close similarity between these phenomena and those of the castration of animals caused by parasites.

Cause of the Direction of Growth of Pollen-tubes.*—According to experiments made by Dr. H. Molisch, the direction of the growth of pollen-tubes is chiefly regulated by two causes—by oxygen, they being negatively aerotropic, and by the stigmatic secretion.

Physiological Researches on the Germination of Seeds.†—M. E. Heckel describes various experiments made to ascertain the action of certain chemicals on the germination of seeds. The results may be summarized as follows:—(1) Contrary to the statements of Detmer, flower-of-sulphur does not accelerate the germination of even those seeds which contain sulphur as one of their constituent elements; (2) Sulphurous acid suspends or arrests germination according to the species of plant with which it is brought in contact; (3) Sulphuric acid in weak solution does not arrest germination; when, however, the percentage reaches 0·2 the germinative process is arrested. Solutions of various salts were tried; salicylate of soda was found, even in small doses, not only to suspend the germination of seeds (*Fagopyrum esculentum*, *Solanum nigrum*, *Brassica Napus*) but also of tubers (*Helianthus tuberosus*); (4) Desiccation of seeds between 40° and 60° C. does not accelerate germination, but permits young plants to develope more rapidly; (5) High humid temperatures of from 40° to 60° considerably accelerate germination.

(2) Nutrition and Growth (including Movements of Fluids).

Fixation of Nitrogen by Leguminosæ.‡—M. E. Bréal has already shown that it is possible to cause nodosities to arise on the roots of Leguminosæ by inoculating them with bacteria. He now gives a *résumé* of certain cultures of Leguminosæ which he has carried on for the last two years, and he agrees with MM. Hellriegel and Willfarth and M. Berthelot, when they state that these plants can grow in a soil which is very poor in nitrogen. By means of their roots they furnish and fix this element in the soil which bears them, and well merit the name of "ameliorating plants," which has for some time been given to them.

Absorption of Nitrogen by Plants from the Soil.§—M. A. Muntz has determined, as the result of a series of experiments, that, contrary to the view generally entertained, the higher plants, such as cereals and beans, can absorb nitrogen directly from the soil when presented to them in the form of a salt of ammonia; and that consequently the nitrification of ammoniacal manures is not an essential condition to their utilization.

Relation between the Physical Characters of Plants and the Richness of the Soil.‖—M. S. Ville describes various experiments made

* SB. K. K. Zool. Bot. Gesell. Wien, xxxix. (1889) p. 52.
† Journ. de Bot. (Morot), iii. (1889) pp. 288–94, 297–305, 315–9, 332–5.
‡ Comptes Rendus, cix. (1889) pp. 670–3. Cf. this Journal, 1889, p. 781.
§ Comptes Rendus, cix. (1889) pp. 646–8. ‖ T. c., pp. 628–31.

with the common hemp, in order to ascertain the relation between the nature of the soil and the colour, habit, weight, and general facies of the plant. The colour was found to be most intense, the height greatest, and the dry weight most, when a manure containing a large proportion of nitrogen was used. When no nitrogen was present the colour was very light. When no phosphate was present in the manure the hemp seemed to be considerably taller and of a deeper colour than when no nitrogen was present; but when no potash was present the height was very much reduced. The absence of lime did not seriously affect the height of the plant.

Wave-growth of Corydalis sempervirens.*—Mr. T. Meehan describes what he terms a recoil in the wave-growth in *Corydalis sempervirens*. The author has pointed out that growth in plants is not by slow and regular modifications, but in rhythms or waves, and that it is the varying intensity of these waves that largely influences those variations that give character to genera and species. In *Corydalis* there is a sleeping of the buds till the apical bud is reached, which keeps on without resting till fully formed. Instead, however, of the next in order downward being started into a renewed growth, as in Compositæ, it is the lowest on the five-flowered raceme that starts the second growth-wave, and the other three upwards then follow successively.

Heredity of Torsion.†—Herr H. de Vries has established that the torsion (Zwangsdrehung) exhibited by *Dipsacus sylvestris* is a hereditary character, fixed by natural selection.

(4) Chemical Changes (including Respiration and Fermentation).

Process of Oxidation in Living Cells.‡—Prof. W. Pfeffer presents the results of a systematic investigation regarding the action on vegetable cells of peroxide of hydrogen. He believes that neither this nor any similar substance furnishing active oxygen arises in living cells or exists in the cell-sap. Hence the processes of oxidation in the living cell must be effected in some other way than by simple imbibition into the protoplasm.

Formation of Glycogen in Beer-yeast.§—M. Laurent shows that the alcoholic fermentation has well-defined limits, for it is only produced when the yeast is supplied with saccharine substances. If the latter be replaced by certain other substances (acetates, glycerin, erythrolene), an excellent development of *Saccharomyces* takes place; but to serve as aliment these carbohydrates must be consumed in contact with air. Of these substances, the author enumerates thirty-four capable of replacing sugar. Not only do these organic substances subserve direct nutrition, but some fourteen assist also in forming reserves of glycogen. And an old experiment of Pasteur is easily explained from the foregoing facts.

Beer-yeast diluted with water and left to itself gives off carbonic acid and produces alcohol. In this autophagic experiment the yeast

* Bull. Torrey Bot. Club, xvi. (1889) p. 293.
† Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 291–8 (1 pl.).
‡ Abhandl. K. Sächs. Gesell. Wiss., xv. (1889) 141 pp. See Bot. Ztg., xxxviii. (1889) p. 621.
§ Ann. Inst. Pasteur, 1889, p. 112. Cf. this Journal, 1888, p. 785.

destroys a substance capable of becoming sugar, and produces an aceto-fermentation. This substance is glycogen. Errera had already clearly perceived the existence of this glycogen. He obtained a red-brown colour with iodine, but no success followed his attempts at isolating it.

M. Laurent has been able to make a step further. By the aid of three imperfect methods, but which gave concordant results, he has calculated the glycogen formed. These three methods were:—(1) To change by means of an acid the glycogen into a reducing sugar, without altering the cell-walls. (2) To weigh a quantity of healthy yeast, to exhaust an equal weight by autophagy, and calculate the loss by subtraction. (3) To estimate the quantity of alcohol produced by a given weight of yeast exhausted by autophagy, and then determine the quantity of saccharine matter consumed.

The result of these researches showed that the quantity of accumulated glycogen might amount to 32 per cent. by weight dry.

The accumulation of glycogen in yeast completes the history of the phenomena of autophagy, and explains the results formerly observed by Pasteur and Duclaux, that yeast loses weight when it is fermented with a relatively small quantity of sugar.

Formation of Albuminoids in Plants containing Chlorophyll.*—By experiments made on several different plants, Herr W. Chrapowicki has determined that the formation of albuminoids takes place in the chromatophores, and that they are not merely transferred there from other parts of the plant where they are first formed. In several instances he was able to establish that the formation of albuminoids can take place in the dark.

Formation of Cane-sugar in Etiolated Seedlings.†—In seedlings of *Lupinus luteus* which had grown for six days in the dark, Herr E. Schulze finds small quantities of a substance agreeing with cane-sugar in its behaviour under the polarizing apparatus, and in its crystalline form. Starch was also found, neither substance being present in the seeds before germination.

Fermentation.‡—M. E. Bourquelot has grouped the various phenomena caused by the action of soluble and organized ferments, interesting alike to chemist, pharmacist, and mycologist. In the introduction the author gives an historical account of fermentation; and the first part of the book is devoted to an account of fermentation produced by soluble ferments. These are classed in the following manner:—(1) The saccharification of starch (diastase); (2) the inversion of cane-sugar (invertin); (3) the doubling of glucosides (emulsin, myrosin); (4) the peptonization of albuminoids (pepsin, trypsin, and papaïne); (5) the coagulation of casein (*présure*); (6) the decomposition of urea (urease). The second part of the book treats of fermentation produced by organized ferments, the principal of which are the alcoholic and lactic fermentations, the ammoniacal fermentation of urea, butyric, sulphydric, acetic, and nitric fermentations.

* Arb. St. Petersburg. Naturf. Gesell., xviii., pp. 1–27 (Russian). See Bot. Centralbl., xxxix. (1889) p. 352. † Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 280–1.
‡ 'Les Fermentations,' Paris, 1889, 8vo, 170 pp. See Rev. Mycol., xi. (1889) p. 209.

γ. General.

Myrmecophilous Plants.*—In the concluding portion of his work on this subject, Prof. F. Delpino enumerates as many as 3030 species, distributed through 292 genera, with extra-floral nectaries or other contrivances for inviting the visits of ants. The natural orders in which the greatest number of myrmecophilous species occur are Mimoseæ (663), Euphobiaceæ (482), and Bignoniaceæ (342). The prevalence of the phenomena in any district is nearly proportional to the average temperature; the central-American region produces the largest number (653). The author believes that both ants and myrmecophilous plants came into existence in the Cretaceous period.

Injury to Vegetation from Gases.†—Herren L. Just and H. Heine describe the injury done to vegetation by various gases, the most injurious being sulphurous acid, which, when taken into the tissues, is oxidized into sulphuric acid, which gradually destroys the protoplasm, causing yellowing of the leaves and final death of the plant. Apple and pear trees, the grape-vine, and conifers, are especially sensitive to its attacks.

Botanical Work of Lacustrine Stations.‡—Prof. F. Ludwig calls the attention of botanists to the scheme proposed by Zacharias for the investigation of lakes. The distribution of aquatic plants, the actual conditions of life, the relations between fauna and flora, e. g. in connection with fertilization, all demand investigation, for which the establishment of lake-side stations is indispensable. "When the 'systematic' survey of a country is roughly completed, then the 'biological' investigation begins," and it is time that this was undertaken in earnest for the lakes.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Antherozoids of Marsileaceæ and Equisetaceæ.§—Continuing his researches on the structure and development of the antherozoids of Cryptogams, M. L. Guignard now describes those of *Pilularia* and *Equisetum*.

The antherozoids of *Pilularia* he finds to be formed on the same general plan as those of the Characeæ, Muscineæ, and Filices; the nucleus, which has taken up a lateral position in the mother-cell, and gives birth to the spiral body, partially absorbs the granular and starchy protoplasm; the rest of the protoplasm forms a vesicle, containing particles of starch, which remains attached to the internal face of the posterior portion of the body, and becomes detached only during the rotation of the antherozoid. The general aspect of the antherozoid closely resembles that of *Sphagnum*, differing chiefly in the number of cilia. The cilia are not attached, as has been stated, to the two first

* Funzione mirmecofila del regno vegetale,' pte. 3, Bologna, 1889, 35 pp. See Bot. Centralbl., xl. (1889) p. 387. Cf. this Journal. 1888, p. 998.

† Landwirthsch. Versuchsstat., xxxvi. (1889). See Bot. Centralbl., xl. (1889) p. 296.

‡ Biol. Centralbl., ix. (1889) pp. 414–6.

§ Bull. Soc. Bot. France, xxxvi. (1889) pp. 378–83. Cf. this Journal, 1889, p. 552.

turns of the spiral, but only to the first half of the anterior turn, where they spring from a small swelling which appears to have hitherto escaped notice.

In his view of the mode of development of the antherozoids of *Equisetum*, M. Guignard differs somewhat from that of Belajeff*; he finds it closely analogous to that in Filices. The nucleus of the mother-cell does not, according to his observation, retain its original globular form, but undergoes the same changes as those which take place in other Vascular Cryptogams, accompanied by special changes in the protoplasm of the mother-cell.

Embryogeny of Lycopodiaceæ.†—Dr. M. Treub has continued his researches on the embryogeny and development of various species of *Lycopodium*, especially *L. cernuum.* The young embryo of this species is fixed to the soil, not by a root, but by a parenchymatous tuber covered with root-hairs, resembling the tuber of *Phylloglossum.* The embryo consists of three parts:—a suspensor composed of a single large cell, the foot, which never projects beyond the prothallium, and a third part, which developes into the embryonal tuber and the cotyledons. It is only after the tuber has attained its full size that the growing point is developed on it; near it springs the first root, which is of exogenous origin. The vascular bundle of the leaves ends before reaching the tuber, which contains none. As a general rule only one embryo is formed on each prothallium. The tuber is infested, as in *L. inundatum*, by the hyphæ of a fungus.

In the embryonal condition *L. cernuum* can reproduce itself in a vegetative way by root-tubers. All the roots of the young plant can produce such tubers, which ultimately become detached from the parent-plant, and develope into new plants. *L. salakense* is propagated in the same way.

The embryonal tuber of *Lycopodium*, which has no analogue among Vascular Cryptogams, cannot be regarded as an outcome of degeneration; it must be a rudimentary organ, and Dr. Treub regards it as an intermediate stage between the unsegmented sporophyte of the Muscineæ and the leafy sporophyte of other Vascular Cryptogams. He proposes, therefore, to call it the *protocorm;* it is analogous to the protoneme of mosses. In *Phylloglossum*, the oldest type, the protocorm plays an important part during the entire life of the individual; in species of *Lycopodium* of the *cernuum* type it occurs only in the embryonal condition; in the epiphytal *Phlegmarium* type only traces of it survive.

Lycopodium Spores.‡—According to Herr A. Langer the spores of *Lycopodium clavatum* contain 1·155 per cent. of neutral mineral constituents (chiefly phosphates of potassium, sodium, calcium, magnesium, iron, and aluminium, with smaller quantities of calcium sulphate, potassium chloride, and aluminium silicate, and traces of manganese), and 49·34 per cent. of an acid greenish-yellow oil, composed of 80–

* Cf. this Journal, 1889, p. 785.

† Ann. Jard. Bot. Buitenzorg, viii. (1889) pp. 1–37 (12 pls.).

‡ 'Ueb. Bestandtheile d. Lycopodium-sporen,' Berlin, 1889, 8vo, 46 pp. See Bot. Centralbl., xl. (1889) p. 355.

86·67 per cent. of a volatile oleic acid, with a variable proportion of glycerin, and a mixture of fatty acids, including myristinic acid. The spores contain also a minimum of 2·12 per cent. of cane-sugar.

Apospory in Ferns.*—Prof. F. Cohn describes experiments in the cultivation of the well-known aposporous fern, *Athyrium Filix-femina* var. *clarissima*. He was unable to establish that the peculiarity could be transmitted by heredity.

Roots of Ferns.†—Herr J. P. Lachmann states that, with the exception of some species of *Trichomanes*, all ferns produce lateral roots, which always spring from definite points in the primary meristem of the summits of the stem. In some cases, however (Cyatheaceæ), they cease growing as soon as their apex has traversed the cortex, while in others they remain completely imprisoned, and may lie dormant for an indefinite period, a fact which has given rise to the erroneous statement that these ferns produce adventitious roots. The roots of ferns have a remarkably long duration of life, a phenomenon largely due to the conserving effect of the filicitannic acid produced in their integument.

The lateral roots spring from the petiole only in *Ceratopteris thalictroides*; in all other ferns from the stem. They may be arranged without any definite order, or their number may have a direct relation to the number of leaves. In the species of *Athyrium*, and in *Ceterach officinarum* and *Lomaria spicant* there is always one root to each leaf; in *Osmunda* and *Todea* two lateral roots to each leaf; in *Cystopteris* one lateral and one median; in some species of *Aspidium* three; in the arborescent Cyatheaceæ it may reach a very large number.

Other Filicineæ resemble Filices more or less in the mode of insertion of the roots. In *Marattia* there is one median root beneath each leaf; in *Angiopteris* two lateral ones; in Ophioglossaceæ and Marsiliaceæ the insertion of the roots has a relationship to the leaves; it is less evident in Equisetaceæ, and disappears altogether in the Lycopodineæ. Among Phanerogams such a relationship is very rare; but occurs in *Nuphar lutea* and in some Aroideæ.

It is possible for the roots to bear buds; but this occurs only very rarely. The stolons of *Nephrolepis* are cauline.

Hybrid Ferns and Mosses.‡—Herr H. v. Klinggraeff gives a *résumé* of the authentic cases at present known of hybridization among Ferns, in all of which a mingling of the characters of the parents is exhibited by the offspring. He doubts whether there are at present any unquestionable instances of hybridization in Mosses.

Muscineæ.

Braithwaite's British Moss-flora.§—The most recently published part of this beautiful work completes the genera of Grimmiaceæ with *Pleurozygodon* (1 sp.), *Zygodon* (5 sp.), *Orthotrichum* (17 sp.), and

* JB. Schles. Gesell. Vaterl. Cultur, 1888 (1889) pp. 157–60. Cf. this Journal, 1889, p. 256.

† Ann. Soc. Bot. Lyon. (5 pls. and figs.). See Morot's Journ. de Bot., iii. (1889), Rev. Bibl., p. cix.

‡ Schrift. Nat. Gesell. Danzig, 1889, pp. 172–8. See Bot. Centralbl., xl. (1889) p. 288.

§ Pt. xii. (1889) 18 pp. and 7 pls.

Weissia (7 sp.). The fruit of *Zygodon gracilis* is figured for the first time. The 11th family or Schistostegaceæ comprises a single species, the remarkable *Schistostega osmundacea*, which is beautifully figured.

Rabenhorst's Cryptogamic Flora of Germany (Musci).*—The first volume of the section of this work devoted to the Musci, by Herr K. G. Limpricht, is now completed. It comprises the Sphagnaceæ, Andreæaceæ, Archidiaceæ, and a portion of the Bryineæ, viz. the Cleistocarpæ and Stegocarpæ (Acrocarpæ), the last 3 parts (11–13) being devoted to the Grimmiaceæ and the completion of the Pottiaceæ. The Ephemeraceæ and the Phascaceæ are included in the Cleistocarpæ. The exhaustive character of the descriptions, both of the genera and species, and the beauty and accuracy of the numerous illustrations, render this one of the most important contributions made in recent years to bryological literature. The systematic portion is preceded by a general description of the structure and modes of reproduction of Mosses, and some practical hints as to their collection and preservation.

Species of Sphagnum.†—Herr E. Russow returns to the controversy with Röll, and restates the arguments in favour of the inconstancy of the characters of the species of bog-moss.

Characeæ.

Characeæ.‡—M. l'Abbé Hy describes the modes of cortication and ramification in the Characeæ, and also the characters which are useful for purposes of classification. *Nitella* may be easily distinguished by the caducous corona of the fruit being formed of ten cells, by the stem having no cortex and two branches in each axil, and by there being no stipules. In *Chara* the corona of the fruit is persistent, and consists of five cells, the stem ordinarily has a cortex, and solitary branches at each node, and stipules are present. The principal difficulty consists, however, in the position of *Chara stelligera*, which has the fruit of a true *Chara* with the vegetative organs of *Nitella*. In order to meet this difficulty the author has proposed for it a new genus *Nitellopsis*.

Pericarp of Characeæ.§—Prof. O. Nordstedt has examined the structure of the pericarp of the fruit in the greater number of known species of *Chara*, *Nitella*, *Tolypella*, *Lichnothamnus*, and *Lamprothamnus*; and classifies it under a number of types, according to the structure of its external layer. This may be quite smooth, or granulated or warted in a variety of ways, or with reticulate elevations and pits between them. In *Chara* the two layers of which the pericarp is composed are usually either both smooth or both similarly ornamented, though this is not always the case.

A new species, *Tolypella hispanica*, is described from Spain.

* Limpricht, 'Die Laubmoose Deutschlands, Oesterreichs u. d. Schweiz,' 1te Abtheil., Leipzig, 1890, 836 pp. and 211 figs.

† Bot. Centralbl., xl. (1889) pp. 417–24. Cf. this Journal, 1888, p. 775.

‡ Bull. Soc. Bot. France, xxxvi. (1889) pp. 393–8.

§ Lunds Univ. Arsskr., xxv. (1889) 40 pp. and 1 pl.

Algæ.

Reinke's Atlas of German Seaweeds.*—In the first part of this magnificent work thirty species or varieties are described and figured, including many new species and several new genera. The larger portion is devoted to the Phæophyceæ, which the author divides into four main families:—the Cutleriaceæ, Tilopterideæ, Laminariaceæ, and Ectocarpaceæ, the last being divided into a number of smaller groups.

Halothrix is a new genus, separated from *Ectocarpus*, coming near to *Giraudia*, but monosiphonous, and with plurilocular sporanges arranged in sori on the upper portion of the filaments. *Symphoricoccus* is distinguished from *Myriotrichia* by its monosiphonous filaments, and from *Elachistea* by the unilocular sporanges occurring on the upper as well as the lower part of the filaments. *Kjellmannia* is a new genus of Punctarieæ, with a polysiphonous thallus bearing monosiphonous branches, and with two kinds of sporange, both plurilocular, one intercalary, the other collected into sori. *Microspongium* is a new genus of Myrionemeæ, resembling *Myrionema* in appearance, but with straight branched filaments, growing by apical growth, and with both unilocular and plurilocular sporanges. *Leptonema* is a new genus of Elachisteæ, with both kinds of sporange; the assimilating filaments, which branch only at the base, spring from a creeping protoneme.

One new genus is described of marine Confervaceæ, *Epicladia*, nearly allied to *Entocladia*, resembling it in habit, and propagated by zoospores. *Blastophysa* is a genus of Siphoneæ, allied to *Valonia*, but resembling *Botrydium* in appearance; it is composed of green vesicles, which were not seen to produce zoospores. *Pringsheimia* is a new genus, possibly belonging to the Ulvaceæ, resembling *Coleochæte* in appearance, but without bristles, epiphytic on various Algæ; it produces both megazoospores and conjugating microzoospores or zoogametes; it may possibly be identical with *Chætopeltis* Moeb.

New Algæ from Brazil.†—From a large collection of Algæ sent from Brazil by Dr. H. Schenck, Dr. M. Moebius describes the following new genera:—

Spirocoleus. Genus Oscillariacearum trichomatibus articulatis spiralibus simplicibus, vagina conspicua præditis. One species, *S. Lagerheimii*, growing among a *Chara*.

Entophysa. Genus Chlorosphæracearum. Thallus in algis majoribus sub cuticula vigens, e cellula subrotunda una vel e pluribus cellulis divisione unius cellulæ exortis constitutus, membrana crassa, loco quodam in verrucam vel stipellum producta, chromatophoro unico parietino discoideo; sporæ divisione contentus cellulæ succedanea evolutæ per foramen membranæ externæ ac simul cuticulæ hospitis exeunt. One species, *E. Charæ*, living within the cell-wall of a *Chara*.

In addition to the above, the following new species are also described:—*Acetabularia Schenckii*, *Dictyopteris Hauckiana*, *Gracilaria Salzmanni*.

* 'Atlas Deutscher Meeresalgen,' 1tes Heft, fol., Berlin, 1889, 34 pp. and 25 pls.
† Hedwigia, xxviii. (1889) pp. 309–47 (2 pls. and 1 fig.).

Marine Algæ of West Indies.*—Mr. G. Murray completes his catalogue of 788 species of Marine Algæ from the West Indies, viz. 444 Florideæ, 112 Phæophyceæ, 187 Chlorophyceæ, and 45 Protophyceæ. With regard to their distribution, he states that the Indian Ocean region has, both relatively to Australia and relatively to its total flora, surprisingly little in common with the West Indies as regards species. As respects the forms which are either confined to or almost exclusively represented in the Tropics, the forms of marine Algæ are, speaking broadly, the same in the East Indies as in the West, while the species are in a very high proportion different.

Division of Micrasterias denticulata.†—Mr. S. Helm describes the mode of binary subdivision of this desmid, the description differing from that of previous observers in the order of appearance of the segments.

Sphærocodium.‡—Under this name Dr. A. Rothpletz describes, as a genus of fossil siphonaceous algæ, calcareous remains from the Raibler strata in the Eastern Alps, hitherto known as ooliths. The genus is nearly allied to *Codium* and *Udotea*, but differs from them in its mode of growth, and in its property of calcareous excretion.

Polyblepharideæ.§—This new family of the lower Algæ is defined by M. P. A. Dangeard as being nearly allied to the Chlamydomonadineæ, from which they differ merely in their mode of development, multiplying by simple longitudinal division and encysting instead of by a sexual process. The fission commences in the chromatophore, and results in the production of two zoospores, each with four or more cilia. They approach the Flagellatæ through *Tetramitina*, but differ from them in being true Algæ; they do not absorb solid food into the body; and they possess chlorophyll, an amyliferous corpuscle, and a cellulose membrane. The following diagnoses are given of the three genera which make up the order:—

Polyblepharides. Body elongated, obtuse in front; protoplasm intensely green; membrane excessively thin, structureless, permitting of amœboid movements at the moment of the germination of the cyst; the nucleus anterior and nucleolated; amyliferous corpuscle posterior; starch dispersed in granules through the protoplasm; one or two vacuoles at the base of the cilia; division longitudinal and free; cysts surrounded by a gelatinous mucus, giving birth, on germinating, to a single zoospore; cilia from six to eight in a tuft. One species, *P. singularis* Dang.

Pyramimonas. Body with four wings or projecting sides; protoplasm differentiated into ectosarc and endosarc; chlorophyll localized in the ectosarc (chromatophore); enveloping membrane striated; nucleus anterior and nucleolated; amyliferous corpuscle posterior; one contractile vacuole; one pigment-spot; division longitudinal and free; cysts spherical, not enveloped in mucus; cilia four. One species, *P. tetrarhynchus* Schmarda.

* Journ. of Bot., xxvii. (1889) pp. 237–42, 257–62, 298–305.
† Journ. New York Micr. Soc., v. (1889) pp. 93–4 (1 pl.).
‡ SB. Bot. Ver. München, Dec. 9, 1889. See Bot. Centralbl., xli. (1890) p. 9.
§ Comptes Rendus, cix. (1889) pp. 85–6. Cf. this Journal, 1889, p. 95.

Chloraster. Body variable in form, with four more or less projecting sides; protoplasm green; one pigment-spot; cilia five, one central one, surrounded by the four others arranged as a crown. Two species, *C. gyrans* Ehrb., *C. agilis* Kent.

Wittrock and Nordstedt's Algæ aquæ dulcis.*—The last three fasciculi (Nos. 851–1000) of this publication include specimens of the following new species:—*Trentepohlia recurvata* W. and N., *Cladophora Nordstedtii* Hauck, *C. Arechavaletana* Hauck, from Uruguay, *Mougeotia gelatinosa* Wittr., *S. Lagerheimii* Wittr., from Sweden, *Cosmarium substriatum* from Lapland, *Hydrocoleum platense* Nordst., from Uruguay.

Fungi.

Thermogenic Action of Fungi.†—Prof. F. Cohn discusses the cause of the elevation of temperature which always accompanies the germination of seeds, as, e. g. the malting of barley. The difference may amount to as much as 17°, and may raise the temperature to as much as 60° C., causing the death of the seeds. Prof. Cohn rejects the theory that this elevation is due to intramolecular respiration,‡ which may continue even after the death of the seed. He believes it to be due entirely to a process of fermentation. The fungi which are the causes of the earlier stages of this phenomenon, species of *Penicillium* and *Rhizopus*, are themselves killed by the high temperature, and it is then carried on entirely by *Aspergillus fumigatus*, which has the power of resisting a very high degree of heat. The highest temperature is reached only when the fungus begins to fructify.

Mycorhiza.§—Herr A. Schlicht describes the occurrence of mycorhiza in a number of plants in which it had not previously been observed, such as, e. g. *Paris quadrifolia;* while young roots are often completely free of the fungus, older roots are always at least partially infested by it. The hyphæ penetrate through the intercellular substance of the epidermal and hypodermal cells into the large thin-walled cortical cells, and there develope into masses which are in connection with the environment of the root, and with one another by filaments which perforate the septa. The spots which are thus infested have quite the same structure as the uninfested spots; the fungus is not a parasite, and has no injurious influence on the root. Similar phenomena were observed in *Ranunculus acer* and other species of the genus, *Caltha palustris*, *Holcus lanatus*, and other grasses. *Leontodon autumnalis* is infested by an endotrophic mycorhiza, such as is found in other Compositæ, Umbelliferæ, Rosaceæ, Gentianaceæ, &c.

Roots infested with endotrophic mycorhiza more closely resemble normal roots than those with the ectotrophic, which often develope into coral-like tubers.

In a large number of natural orders some of the species are ordinarily attacked by mycorhiza, while others are entirely free from it. It was

* Bot. Notis., 1889, pp. 157–68 (6 figs.).
† JB. Schles. Gesell. Vaterl. Cultur, 1888 (1889) pp. 150–6.
‡ Cf. this Journal, 1887, p. 619.
§ 'Beitr. z. Kenntniss . . . . der Mykorhizen,' 8vo, Berlin, 1889, 35 pp. and 1 pl., See Bot. Centralbl., xl. (1889) p. 383. Cf. this Journal, 1889, p. 422.

not observed in any species of Rhinanthaceæ, Droseraceæ, Cruciferæ, Papaveraceæ, or Cyperaceæ; aquatic and arenaceous plants are destitute of it; it is found only in those which grow in humus. In *Drosera* the author observed a peculiar condition of the roots; the long brown root-hairs are invested by a dense mantle of dead vegetable remains, *Sphagnum*-leaves, &c., only the tips of the roots remaining exposed.

New American Phytophthora.*—Mr. R. Thaxter describes a new *Phytophthora*, *P. Phaseoli*, parasitic on the pods, stems, and leaves of the Lima bean, *Phaseolus lunatus.* The mycelial hyphæ are branched, rarely penetrating the cells of the host by irregular haustoria; conidiophores slightly swollen at their point of exit through the stomates, arising singly or one to several in a cluster, simple or once dichotomously branched, and with one or more inflations below their apices; conids oval or elliptical, with truncate base and papillate apex, 35–50 μ by 20–24 μ. Germination by zoospores, usually fifteen in number, or rarely by a simple germinating hypha. Oosperms unknown.

Beer-yeasts.†—M. E. C. Hansen shows that all the species of *Saccharomyces* pass, in their evolution, successively through the different forms which Reess regarded as specific. The latter based his species on characters drawn from the form of the cells. The author's results were obtained by means of cultivations started from a single cell.

This method, conceived in 1882, has enabled the author to establish that the high and low ferments are not convertible the one into the other, and the opposite results obtained by Pasteur and Reess must have been due to a mixture of the two species.

According to the author, the species of Saccharomycetes are defined by the temperature curves of the development of their spores, by critical temperatures (death, &c.), by the budding, and by the fermentative power.

If various kinds of *Saccharomyces* be cultivated under identical conditions, the form of the individual cell furnishes specific characteristics for the whole group and accordingly for the species, although the course of spore development remains the most important characteristic. Yet the form of the single cell should only be employed for recognition purposes with the greatest caution, because almost all kinds of the genus *Saccharomyces* may appear under the same form, although of course not under the same conditions. It would, therefore, seem easy to transform one species into another if the favourable conditions were ascertainable; but Prof. E. C. Hansen, after more than four years' experimentation, has failed with the aid of variations of temperature to transform the low yeast into the high yeast, and *vice versâ.*

In practice it was of course important that the cultivation should be quite pure, and this was effected by starting from a single cell; yet in the case of the low yeast Carlsberg 1, very different appearances were obtained: some of the cells might have been taken for *S. pastorianus*, others for those of *S. cerevisiæ.* In cultivations in beer-wort *S. cerevisiæ* did not alter in form, while *S. pastorianus*, which at first retained its sausage-like shape, completely lost it after several generations. So that the difference between the two series of experiments became constantly less and less, and finally in both oval cells only appeared. That the

* Bot. Gazette, xiv. (1889) pp. 273–4. † Ann. de Microgr., i. (1888) pp. 11–18.

resemblance was not merely superficial was shown by the production of an identical beer.

Hence the important practical conclusion, that not only microscopical examination of the cells, but also the results of first cultivations are unsafe guides.

Morphology and Biology of Oidium albicans.*—MM. G. Linossier and G. Roux state that if *Oidium albicans* be cultivated in an artificial medium, within certain limits of temperature, a third undescribed sporiferous form will be found to exist. The authors cultivated the fungus in a liquid having the following composition per litre:—saccharose 20 gr., tartrate of ammonium 10 gr., phosphate of potassium 1 gr., sulphate of magnesium 0·2 gr., chloride of calcium 0·1 gr., the temperature being maintained at from 30–35° C., and were able definitely to determine the presence of chlamydospores, and several times to verify the absence of true ascopores. They state further that in the cultures of this fungus the nature of the form depends on the molecular structure of the nourishment. Thus if a small quantity of saccharose be present in the liquid short mycelial filaments will be found to exist, these filaments becoming longer as the quantity of sugar increases. The character of the fungus varies similarly if glycerin or mannite be present, or if the nourishment consist only of a simple ammoniacal salt. Finally the authors state that if the fungus has been cultivated for several generations in a medium where it affects the globular-filamentous form, it more easily takes this form when transported to new media.

New Parasite of Agrostis segetum.†—Prof. N. Sorokine describes and figures a new parasite which has been met with in the Government of Kazan on *Agrostis segetum*, to which he has assigned the name *Sorosporella Agrostidis*, the spores somewhat recalling those of *Sorosporium*, although it has nothing in common with the Ustilagineæ. M. Giard considers *Tarichium uvella* Krass., parasitic on *Agrostis*, as identical with this new fungus.

Fungus-parasites.‡—Prof. R. Hartig finds that the species of *Melampsora* which attack various species of poplar, *M. Tremulæ*, *populina*, and *balsamifera*, have their æcidio-form in the *Cæoma* of the larch, *C. Laricis* being identical with the *M. populina* of the black poplar as well as with the *M. Tremulæ* of the aspen.

He describes also a hitherto unobserved disease of seedling pines and firs, which causes great destruction, and which is referable to an undescribed parasite belonging to the Pyrenomycetes. The mycele enters the stomates as well as attacks the wall of the epidermal cells; the gonids resemble those of a *Nectria*.

Report of the Chief of the Section of Vegetable Pathology for the year 1888, Washington.§—Mr. B. T. Galloway in this report describes and figures the following:—potato-rot (*Phytophthora infestans*); black-rot of the tomato (*Macrosporium Solani*), also *Fusarium Solani* and *Cladosporium fulvum*; brown-rot of cherry (*Monilia fructigena*); powdery

* Comptes Rendus, cix. (1889) pp. 752–5.

† Bull. Scient. France et Belg., iv., 1889. See Rev. Mycol., xi. (1889) p. 215.

‡ SB. Bot. Ver. München, Nov. 11, 1889. See Bot. Centralbl., xl. (1889) p. 310.

§ Rev. Mycol., xi. (1889) pp. 217–8.

mildew of cherry (*Podosphæria oxyacantha*); cracking of the pear (*Entomosporium maculatum*); leaf-spot of rose (*Cercospora rosæcola*); plum-pockets (*Taphrina Pruni*); apple-rust (*Rœstelia pirata*); *Septosporium* on grape-leaves (*Septosporium heterosporium*); leaf-spot of maple (*Phyllosticta acericola*); sycamore-disease (*Gleosporium nervisequum*); poplar-leaf-rust (*Melampsora populina*).

Agaricini.*—M. V. Fayod gives a detailed account of the morphology of this group of Fungi, and of the relationship to one another of its various families. The various organs are described under the following heads:—(1) the mycele, including the primary mycele, the secondary mycele, and the pseudorhizes. Under the first head the mycele may be either ordinary or persistent; the persistent primary mycele may be either nematoid (filamentous), spartoid (corticated), or tuberous (sclerotes), and is always a reservoir for food-materials; the last form may be again either exosclerotes or mycelial tubercles. By pseudorhizes the author understands root-like mycelial structures which develope at the base of the carpophore from its cells. (2) The carpophore (receptacle), including the stipe, the pileus, and the lamellæ. Under this head are treated three kinds of tissue, the fundamental, the connecting, and the strengthening; excretions, whether of a gaseous, liquid, or solid nature; and the phenomenon of luminosity, a list of all known luminous agarics being given. Under the head of the lamellæ are described the trama, the subhymenium, the hymenopode (which is found sometimes between the subhymenium and the trama), and the hymenium, including the cystids, basids, sterigmates, and spores. Among spores reference is made to the rarely occurring chlamydospores, microconids, and gemmæ. The development of the various forms of the receptacle and of its accessory organs are then described in detail.

In the systematic portion of the paper the genera of Agaricini are classified under six series (a diagnosis of which is not always given) and twenty-seven tribes, and the following new genera are described:—In Pleuroteæ, *Omphalotus*, *Urospora*, *Pleurotellus*; in Lepioteæ, *Cystoderma*, *Fusispora*; in Naucorieæ, *Pholiotina*; in Pholioteæ, *Ryssospora*, *Myxocybe*; in Pluteideæ, *Schinzinia*; in Cortinarieæ, *Sphærotrachys*; in Pratelleæ, *Astylospora*, *Pluteopsis*, *Psilocybe*, *Glyptospora*; in Coprinoideæ, *Lentispora*, *Ephemerocybe*; in Paxilleæ, *Gymnogomphus*; in Fusisporeæ, *Hexajuga*.

Cultures of Nyctalis asterophora.†—M. J. Costantin states that in 1859 De Bary returned to the opinion of Krombholz, and regarded *Asterophora* as composed of the chlamydospores of *Nyctalis*, and Brefeld has definitely closed the debate by establishing that the pure cultures of the basidiospores of *Nyctalis* give *Asterophora*. The author describes cultures made by himself on sterilized potato dipped in orange juice.

Cuprophilous Fungus.‡—Prof. F. Cohn describes the mycele of a fungus (species undetermined) from the copper-mines of Rio Tinto in Spain, which grew vigorously and produced conids in soil containing a considerable amount of both sulphate of iron and sulphate of copper.

* Ann. Sci. Nat. (Bot.), ix. (1889) pp. 181–411 (2 pls.).
† Journ. de Bot. (Morot), iii. (1889) pp. 313–5.
‡ JB. Schles. Gesell. Vaterl. Cultur, 1888 (1889) p 166.

Protophyta.

α. Schizophyceæ.

Genetic Connection of Scytonema, Nostoc, and Glœocapsa.*—Herr H. Zukal describes the result of experiments made chiefly on *Scytonema myochrous*, in order to ascertain its power of assuming other forms. For this purpose the *Scytonema*-filaments were placed in the axils of moss-leaves grown in pots. In about three weeks a change commenced, the sheath swelled up and became more transparent, and the filament gradually assumed a blue-green colour, and was divided repeatedly by very fine septa. The cells now assumed a more rounded form, and, the filament growing much faster than its inclosing sheath, became necessarily twisted and coiled in a variety of ways. Heterocysts and hormogones were also gradually formed, and the separate portions of the filament became inclosed in a very thin internal secondary sheath. The *Scytonema* had now assumed all the characters of *Nostoc rupestre* or *microscopicum*, except that it consisted of only a single filament, and that the outer sheath took no part in its curvature. When cultivated in a nutrient solution, this *Nostoc*-form continued to reproduce itself; while, if grown in distilled water, it had a tendency to reassume a *Scytonema*-condition. Continued cultivation on moss leaves induced still further degeneration, and the *Nostoc*-filament gradually broke up into separate cells, each invested with its own mucilaginous sheath, in which condition it is a *Glœocapsa*, closely resembling *G. æruginosa;* and this again, by further culture, became a *Chroococcus*, with very thick sheath.

Parasitism of Nostoc on Gunnera.†—According to Herr P. Merker, the filaments of *Nostoc* enter the leaves of *Gunnera macrophylla* through the mucilage-canals in the glands, where they first take possession of the empty space caused by the conversion into mucilage of individual gland-cells. From here filaments find their way into the intercellular spaces of the starchy parenchyme which surrounds the glands. When a *Nostoc*-filament enters a cell of this tissue, it applies itself closely to the cell-wall, dissolves it or converts it into mucilage, advances to the interior of the cell, consumes the whole of the starch, and completely fills up the cell. Individual filaments then attack neighbouring intercellular spaces, and the contents of other cells are consumed in the same way.

β. Schizomycetes.

Transformations of Microbes.‡—M. A. Chauveau has continued his researches on the limits, conditions, and consequences of the variability of *Bacillus anthracis;* and now describes those in which he has tested the ascending or reconstituting variability of this form. He finds that the *Bacillus anthracis* may exhibit three types, the respective properties of which appear to have been definitely acquired.

(1) The bacillus brought to the bottom of the scale of descending variation, non-virulent, but still with vaccinal properties.

(2) The bacillus partially revivified by ascending variation and

* Oester. Bot. Zeitschr., xxxix. (1889) pp. 349–54, 390–5, 432–5 (1 pl.).
† Flora, lxxii. (1889) pp. 211–32 (1 pl.).
‡ Comptes Rendus, cix. (1889) pp. 597–603. Cf. this Journal, 1889, p. 796.

again capable of killing an adult guinea-pig and even a rabbit, but ineffective against ruminants or horses, though highly vaccinal towards them.

(3) The bacillus whose revivification has been rendered complete, that is, is mortal to the sheep; this type is probably still only vaccinal to the cow or the horse.

It will be remembered that the non-virulent bacilli were obtained by cultivations brought into contact with compressed oxygen. To restore the virulence it is necessary to add blood to the cultivation in contact with greatly rarefied air. If the blood be that of a guinea-pig the bacilli produced will kill mice and just-born guinea-pigs, and, later on, adult guinea-pigs and rabbits. To make these bacilli capable of killing sheep, the blood of a sheep must be added, and the spores of cultivations thus prepared are mortal to small ruminants.

Metabolism of Micro-organisms.*—Dr. G. Strazza has made some experiments with the object of ascertaining to what extent micro-organisms cause metabolism of the nutrient medium in which they are cultivated. The result of his experiments is that a distinct loss of weight can be demonstrated, but this loss is extremely small, and is represented in the second or third place of decimals. Secondly, that this loss of weight is accompanied by the production of carbonic acid.

The micro-organism which was mostly used for these experiments was *Micrococcus prodigiosus.* In the first set all that was requisite was to weigh the tubes carefully before and after growth, and compare this loss with the loss of weight due to evaporation from an equal surface of gelatin. The next thing was to show that the loss was due to development of gas, and this was effected by inverting the inoculated test-tube over caustic potash, when it was found that the liquid ascended 5–10 mm. That the gas developed by the metabolism of the micro-organisms was carbonic acid was shown by its causing a precipitate with lime water.

Action of the Gastric Juice on Pathogenic Microbes.†—MM. J. Strauss and R. Wurtz have examined the action of the gastric juice of the dog, man, and sheep on the bacilli of tubercle, anthrax, enteric fever, and cholera. The gastric secretion was placed in test-tubes, inoculated with the microbes, and kept at a temperature of 38° C. After various periods of time inoculation experiments in guinea-pigs and rabbits showed that tubercle bacilli survived the action of the gastric juice up to six hours sufficiently well to produce a general tuberculosis. From 8–12 hours a tubercular abscess was formed at the inoculation site, and this quickly healed. After 18 hours the bacilli were either dead or had lost their virulence. Anthrax bacilli without spores were killed in 15–20 minutes, and the spores died after 30 minutes. Under similar conditions typhoid bacilli died in 2–3 hours, and cholera bacilli after 2 hours.

Further experiments with hydrochloric acid in the proportion of 0·9, 1·7, and 3 per thousand on anthrax, cholera, and typhoid bacilli gave similar results to those obtained with gastric juice. Hence the authors

* MT. Embryol. Instit. Univ. Wien, 1888, pp. 8–13.

† Arch. Méd. Expér. et d'Anat. Pathol., 1889, No. 3. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 39.

conclude that the antiseptic effect of the gastric juice is to be ascribed to its containing hydrochloric acid.

New Schizomycetes.*—In a review of the additions to the flora of Bohemia as far as fresh-water algæ and saprophytic bacteria are concerned, made in the course of the year 1888, Prof. A. Hansgirg enumerates the following new species of Schizomycetes:—*Leptothrix cellaris*, *Bacillus vialis*, *Mycothece cellaris*, *Hyalococcus cellaris*, *Micrococcus thermophilus*, *M. subterraneus*.

Bacterium phosphorescens.†—In discussing the origin and causation of the light emitted by *Bacterium phosphorescens*, Dr. K. Lehmann observes that there are two obvious possibilities to be considered. First the illumination may be a vital phenomenon accompanied by the production of CO_2, heat, &c. Secondly it may arise from the oxidation of a photogenous substance excreted by the cells, and resembling the pigment formation of many chromogenous species. This photogen must therefore be very sensitive to chemical reagents.

In favour of the former view are the following facts. Cultivations when emitting light always contain illuminant bacteria, and in this condition can always be successfully cultivated. All germicidal media destroy the illumination. Lastly, in correspondence with the great resistance *B. phosphorescens* shows to low temperatures, the illuminative power is preserved at similarly low temperatures. In association with this is to be counted in the fact that while development diminishes with increased temperature, so also does the emission of light.

These facts seem to show that the light emitted by the fungi is always associated with their vitality, and is therefore not reconcilable with a photogenic property unless the latter has ascribed to it all the characteristic of a living plasma.

Specific Microbe of the contagious Bovine Pneumonia.‡—M. S. Arloing, by making direct plate-cultivations from the pulmonary secretion of an ox affected with cattle-plague, was able to isolate four micro-organisms, a bacillus which rapidly liquefies gelatin, and three micrococci. These he calls *Pneumobacillus liquefaciens*, *Pneumococcus gutta-cerci*, *Pneumococcus lichenoides*, *Pneumococcus flavescens*. The author assumed that one of these four microbes was the specific cause of the pneumonia. By means of subcutanous injection of pure cultivations, it was found that the bacillus produced the greatest effect, and also that when injected in larger doses, pulmonary effects were produced resembling those of the original disease. From those results the author concludes that he has discovered the specific cause of contagious bovine pneumonia.

Two pseudo Hay-Fungi.§—Dr. L. Klein describes two bacilli which, from their resemblance in certain particulars to *B. subtilis*, he calls false hay-fungi.

The first of these, *B. leptosporus*, was found as an impurity in a flask containing grape-sugar-meat-extract solution, wherein it formed a thick

* SB. K. Böhm. Gesell. Wiss., 1889, pp. 121–64.

† Biologisches Centralblatt, ix. (1889) pp. 479–80.

‡ Comptes Rendus, cix. (1889) pp. 428–30, 459–62.

§ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 313–9, 345–9, 377–83 (2 pls.).

white scum. The second was found in the blood of a cow which was supposed to have died of anthrax. The coarse appearances of the cultivation were similar to those of *B. leptosporus*. These two bacteria are designated hay-fungi, not only from the resemblance of the scum which they form on the surface of the nutrient media, but also from the habitual likeness which the individual elements and the chains of rodlets show to those of *B. subtilis*.

B. leptosporus receives its name specially from the length of the rectangular endospores, and *B. sessilis* from the fact that one end of the germinating primary element remains covered for a considerable time by the spore-membrane, and thus there is imparted to the development of the micro-organism a special characteristic hitherto not observed in any other species.

These bacteria were found to thrive well in most solutions, but best in meat-extract to which grape-sugar was added. The observations were made in the usual way from cultivations in hanging drops, and examined under high powers. The author gives minute details of his observations, and numerous illustrations of the micro-organism at various periods of development.

Bacteria-destroying Power of the Blood.*—In experimenting on the property of blood-serum devoid of cells as to its power of destroying micro-organisms, Dr. F. Nissen used the blood of dogs and rabbits. The blood was withdrawn from the carotids and received into sterilized vessels heated up to 35° C., and then defibrinated with sand. In the result it was found that while the various kinds of bacteria did not behave in the same way, yet a great number were found to be quickly destroyed by the blood influence. Of the pathogenic species which were found to be susceptible to this blood power were the bacteria of cholera asiatica, anthrax, typhoid, and pneumonia, and of the Saprophytes, *Coccus aquatilis*, *Bac. acidi lactici*, *subtilis*, *Megatherium*. On the other hand, *Staphylococcus aureus*, *albus*, *Streptococcus erysipelatis*, bacilli of fowl cholera, swine plague, *Proteus vulgaris*, *hominis*, *B. fluorescens*, *prodigiosus*, *aquatilis*, and others multiplied with great facility. The power of killing bacteria possessed by the blood is also influenced by certain conditions and reagents; thus, if heated for half an hour to 54°–56° C. it loses it, as is also the case if allowed to stand for some hours, or if its coagulability be affected as by the intravenous injection of pepton, or by admixture with sulphate of magnesia.

Moreover, the quantity of micro-organisms has great influence on the result, the annihilating influence of the blood being only able to prevail up to a certain extent; when this point is reached, the blood becomes quite a perfectly suitable medium for their development.

The author concludes from the foregoing experiments, and also from others made with horse's blood, that the power of the blood to overcome bacteria is to be regarded as a destructive property residing in the plasma, but he does not explain if there be any reason to suppose that there exists a definite separable constituent of the plasma which is capable of producing this effect.

* Zeitschr. f. Hygiene, vi., Heft 3. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 36–8.

Phagocytes.*—Dr. W. Osler, in discussing the doctrine of phagocytes, and the theory according to which they play an important part in protecting the organism against the invasion of germs, declines to express a positive opinion of the relations between the phagocytes and bacteria, on the ground that our present knowledge is insufficient. An experience of 150 cases of malaria, in which the behaviour of leucocytes to the various forms of hæmatozoa and the manner in which the leucocytes pick up the pigment granules were observed, shows that here and there leucocytes containing amœboid forms of the parasites are met with. But the absence of any considerable number of white cells containing parasites prevents the acceptance of the hypothesis of aggression. It is more probable that the pigment granules are taken up after the disintegration of the parasites, or that the phagocytic action takes place where more favourable conditions exist, as in the spleen or in the marrow of bone (Metschnikoff). On the ground of examinations of spleen, liver, and marrow, the author concedes an increased activity of the leucocytes, but one not sufficient to form a basis for a theory, and he concludes that while phagocytosis is, in the animal kingdom, a widespread and important physiological process, and while it undoubtedly plays an important part in many pathological conditions, the question whether the white cells possess an actual militant function against the micro-organisms of disease must at present be considered as unanswered.

Bacterial Disease of Corn.†—Mr. T. J. Burrill has from 1881–1889 observed a disease which attacks young corn, and frequently causes great devastation. The first indication is a dwarfish wasted appearance of the plant. The condition of the soil seems to play no unimportant part in the spread of the disease, for the author was able to determine that in a large rye-field, of which one part had been a reclaimed marsh, the plants herein were diseased, while in the drier portions there was scarcely any disease. The plants attacked stop growing, become yellow, dark slimy spots appear on stalk, leaf, and root, and then they soon die. Microscopical examination of the dark slimy masses, which occur within and without the plant, shows that they contain a large quantity of rod-shaped bacteria and others of a spheroidal shape, both varieties being of one and the same species.

These bacteria were found to develope easily at ordinary temperatures, but above 36° C. their growth ceased. At first independent motion was seen, but later observations failed to verify this. They do not liquefy gelatin.

In fluid media the individual elements are larger than in solid media. Their breadth is about $0 \cdot 65\ \mu$, and they vary in length from $0 \cdot 8$–$1 \cdot 6\ \mu$. Spore-formation was never observed.

Bacillus of Grouse Disease.‡—Prof. E. Klein communicates some further facts relative to the bacillus of grouse disease. He had

* New York Med. Record, xxxv. (1889) p. 393. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 183–4.

† University of Illinois Agricultural Experiment Station, Champaign, 1889, Bull. No. 6, pp. 165–73. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 70–1.

‡ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 81–3.

previously found that guinea-pigs and mice were susceptible on subcutaneous inoculation, while fowls and pigeons were refractory thereto. He now states that wild birds are susceptible, but that they are so in different degrees, for while yellowhammers and greenfinches are so sensitive that they soon die, starlings are somewhat refractory. The small birds die in 20–72 hours, and on examination present the same appearances that are seen in grouse, i. e. hyperæmia and inflammation of both lungs, hyperæmia of the liver, petechiæ in the intestine. The bacilli are less frequent in the blood than in the lungs, where they are found in large numbers (cover-glass preparations were stained in a 2 per cent. aqueous solution of rubin, then washed in water, and contrast stained with methylen-blue for 1/2–1 minute; this stained the blood-discs red, while their nuclei and the bacilli were of a blue or purple colour.)

Feeding the birds with cultivations gave no positive results, but it was found that the contagion could be conveyed through the air, a sick yellowhammer in one cage passing the disease on to six others in a new adjacent cage.

It was also found from inoculation experiments that cultivations from the heart-blood or lung-juice of mice were less virulent than those from birds, consequently the author thinks this may aid in obtaining a protective virus.

Spirillum endoparagogicum.*—Prof. N. Sorokin, who some time ago described this interesting endosporous *Spirillum*,† has from recent observations discovered that the spore membrane remains within the mother-cell. This was effected by using the iris diaphragm, and then, when the aperture was considerably contracted, tilting the light a little sideways. In this way the outline of the membrane could just be descried; with much light it was quite invisible. It was also found that by killing motile cells with weak iodine solution, a cilium could, with high power (water-immersion apochromatic), be detected at one or both ends.

Cultivation experiments quite failed, owing apparently to the extreme sensitiveness of the parasite to any added fluid.

Nasal Bacteria in Health.‡—Dr. J. Wright examined the nasal secretion of ten healthy persons of different ages for bacteria. The secretion had a neutral or slightly alkaline reaction. The germs were isolated by the plate method. There were found in six cases *Staphylococcus pyogenes albus*, *aureus* and *citreus;* in three, *Micrococcus flavus desidens;* in one, *Bacterium lactis aerogenes;* in one, *Penicillium glaucum;* in one, *Micrococcus cereus flavus;* in one, *M. tetragonus;* and in three, some undetermined species. The numerical preponderance of suppurative cocci agrees with the results of other authors.

The author further attempted to determine what was the proportion of bacteria before and after inspiration, or in other words, how far the nose acts as a bacteria filter. He used Sedgwick and Tucker's apparatus

* Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 123–4 (3 figs.).

† See this Journal, 1887, p 631.

‡ New York Med. Journ., July 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 135.

with Petri's modification, and found that with a rapidity of 1 litre a minute, 3/4 to 4/5 of the bacterial contents of the inspired air were deposited in the nasal cavity or its neighbourhood.

Increased Virulence of Vibrios.*—M. N. Gamaleia has discovered a method whereby increased virulence can be imparted to certain microbes, for example, *Vibrio Metschnikovi*, and Koch's cholera vibrio. Rabbits, which are but little sensitive to *V. Metschnikovi*, cannot be infected by intravenous injection, but if the vibrio be injected into the lungs the microbes from the pleural exudation are found to have acquired toxic properties. The toxicity is first shown by the diminution of the duration of illness, i. e. for equal volumes of infective fluid (2 ccm.). The animals die in two hours or even one, with the customary post-mortem appearances: intestines distended with fluid, exfoliated epithelium, presence of numerous vibrios, pale spleen, hæmorrhagic pleural exudation, and vibrios in the heart's blood.

Rendered thus virulent, the vibrios kill otherwise immune fowls, sheep, and dogs, while in rabbits they set up a disease resembling a septicæmia.

The increased virulence disappears if the vibrio be bred outside the body, and indeed inside, for the virulence seems to be limited to the pleural exudation, not being found in the vibrios from the blood. It was also found that high degrees of virulence could be obtained by the combination of ordinary vibrios and the sterilized poison of the virulent vibrios.

Exactly parallel results were obtained with the white rat and the cholera vibrio. Hence the author concludes that it is possible to obtain an increase of virulence in the bodies of refractory animals, and that this possibility or predisposition to infection, as it is called, consists of two factors—the "prédisposition humorale" and the "prédisposition cellulaire." In the former the juices of the body are susceptible in a greater or less degree to the influence (and multiplication) of the virus and the formation of toxines; in the latter the cell-elements betray a greater or less tendency to a local reaction.

Antiseptic and Germicide Action of Creolin.†—Van Ermengem, as the result of his experiments with creolin, states that he considers it to be an antiseptic of the first rank. The germicidal effect of creolin was tested with typhoid stools and micro-organisms of suppuration; and though its action was somewhat interfered with by the presence of serous and albuminous fluids, 5 per cent. solutions gave most satisfactory results. These, therefore, and also on account of their non-irritating properties, are to be preferred to carbolic acid or to sublimate solutions acidulated with tartaric acid.

In 5 per cent. solution creolin is found to be a certain and prompt disinfectant. In addition, its deodorizing and antiseptic properties, as well as its safety and the ease with which it is manipulated, give it a high place among disinfectant deodorizers.

* Annales de l'Institut Pasteur, 1889, p. 609. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 75–6.

† Bull. de l'Acad. Royale de Méd. de Belgique (ser. iv.). iii., No. 1. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 75–6.

Microbic Products which favour the development of Infection.*—M. G. H. Roger finds that bacterial secreta have partly poisonous, partly vaccinative properties. There are therefore among these some which favour the development of certain viruses. This latter phase has been observed by the author in the bacillus of symptomatic anthrax. This bacillus, which by itself is harmless to rabbits, speedily kills them if another microbe be injected along with it. This can be done with *Staphylococcus pyogenes aureus*, *Proteus vulgaris*, and especially with *Bacillus prodigiosus.*

A similar result can be obtained from the anthrax bacillus itself. For if the serum from an anthrax tumour be deprived of its cell-elements by means of a porcelain filter, 4–5 ccm. per kilo. of live weight can be injected without harm, while 1–1·5 ccm. coupled with the anthrax bacillus quickly kills. The morbid predisposition induced by such a procedure is, however, of short duration, lasting not more than 24 hours, after which the animal again becomes refractory. Hence it would seem that a vaccinative effect is preceded by a period of diminished resistance to the virus.

Another observation showed that the anthrax bacillus did secrete products favouring its development; for while the virus, if injected into the thigh, was powerless, the same virus was found to be fatal if injected into the anterior chamber of the eye at one and the same time. Hence the products of the latter injection must have arrested the immunity in the muscles, and accordingly it may be concluded that the resistance of animals to infectious diseases can be affected by harmless as well as by pathogenic bacteria.

Bacillus of Leprosy.†—Dr. O. Katz mentions two series of experiments made by him to obtain cultivations of the leprosy bacillus. Both were failures. In the first instance leprous blood was inoculated on coagulated human hydrothorax fluid. The tubes were incubated in a thermostat for about two months at a temperature varying from 30–34° C. No evidence of the multiplication of the bacilli was found. In the second series, pepton-glycerin-agar was used, and the tubes were incubated for a month at a temperature of 37° C. At the end of this period the tubes were still sterile.

Bacillus isolated from a fatal case of Cholera Nostras.‡—Dr. B. Schiavuzzi describes a bacillus which he isolated from the intestinal contents of a case of cholera nostras. The organism was separated in the usual way on gelatin plates, the colonies in 24 hours forming small milky-looking clumps, about 1 mm. in size. Under a 1/15 homogeneous-immersion lens the colonies were found to consist of straight rods 1·7–2 μ long, 0·85 μ broad. Every individual contained at both ends well-marked spores, which were also seen free. Both rods and spores stained easily with fuchsin. In hanging drops swarming movements were visible. Cultivated on potato the colonies were of a whitish-yellow colour, the rods grew larger, and the spores were very distinct.

* Comptes Rendus, cix. (1889) p. 192. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 60–1.

† Proc. Linn. Soc. N.S.W., iv. (1889) pp. 325–8.

‡ Bollettino Soc. Ital. Micr., i. (1889) pp. 45–50.

This bacillus is said by the author to possess considerable affinities with *Bacillus choleræ gallinarum*, *B. typhi abdominalis*, *B. neapolitanus*, and *Bacterium coli commune*, but is distinguishable therefrom by the size of the individual or the size, shape, or colour of the colonies, and is to be regarded as a pathogenic microphyte capable of exciting inflammation of the intestine.

No name is proposed for the micro-organism, and no experiments on living animals with pure cultivations were made.

In addition to the foregoing, the author also isolated a bacillus which is identical with *Bacillus malariæ*.

Fraenkel and Pfeiffer's Microphotographic Atlas of Bacteriology.*—Drs. Fraenkel and Pfeiffer have just issued the fourth instalment of the Atlas of Bacteriology. This part deals with the bacillus of anthrax, and six plates, accompanied by explanatory text, are given.

Bacteria and Disease.†—The following provisional table is intended to show the present status of bacteriological investigation with reference to the causation of some of the more important diseases.

(1) *Diseases whose bacterial cause is determined with comparative certainty*:—Anthrax, caused by *Bacillus anthracis*. Aphtha, caused by *Oidium albicans*. Cholera, caused by comma bacillus. Erysipelas, caused by *Streptococcus erysipelatosus*. Gonorrhœa, caused by the gonococcus. Leprosy, caused by the lepra bacillus. Malarial fever, caused by *Bacillus malariæ*. Meningitis (epidemic, cerebro-spinal), caused by *Diplococcus lanceolatus*. Pertussis, caused by a bacillus. Pneumonia, caused by *Diplococcus pneumoniæ*. Purpura, caused by *Monas hæmorrhagica*. Pyæmia, caused by *Streptococcus pyogenes*. Relapsing fever, caused by a spirillum. Tetanus, caused by a "pin-head" bacillus. Tuberculosis, caused by the tubercle bacillus. Typhoid fever, caused by *Bacillus typhosus*. Typhus fever, caused by a bacillus.

(2) *Diseases probably bacterial, but whose exciting cause has not been certainly determined*:—Carcinoma, dengue, diphtheria, dysentery, gangrene, glanders, measles, parotitis, rabies, rheumatism, rötheln, scarlatina, syphilis, yellow fever.

It is probable that all catarrhal diseases, such as bronchitis, conjunctivitis, diarrhœa, &c., are of bacterial origin, and that various bacteria are engaged as causative factors in different varieties of these several diseases. These have been isolated with varying degrees of certainty.

With regard to diphtheria, it is probable that two or more diseases are included under this name, and that more than one bacterium is capable of inducing the formation of pseudo-membrane.

PRUDDEN, S. MITCHELL, M.D.—**The Story of the Bacteria, and their relations to health and disease.** (New York, 1889, 16mo, 143 pp.)
Micr. Bull. and Sci. News, VI. (1889) p. 48.

* Berlin, 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 58.
† Amer. Mon. Micr. Journ., x. (1889) pp. 255–6.

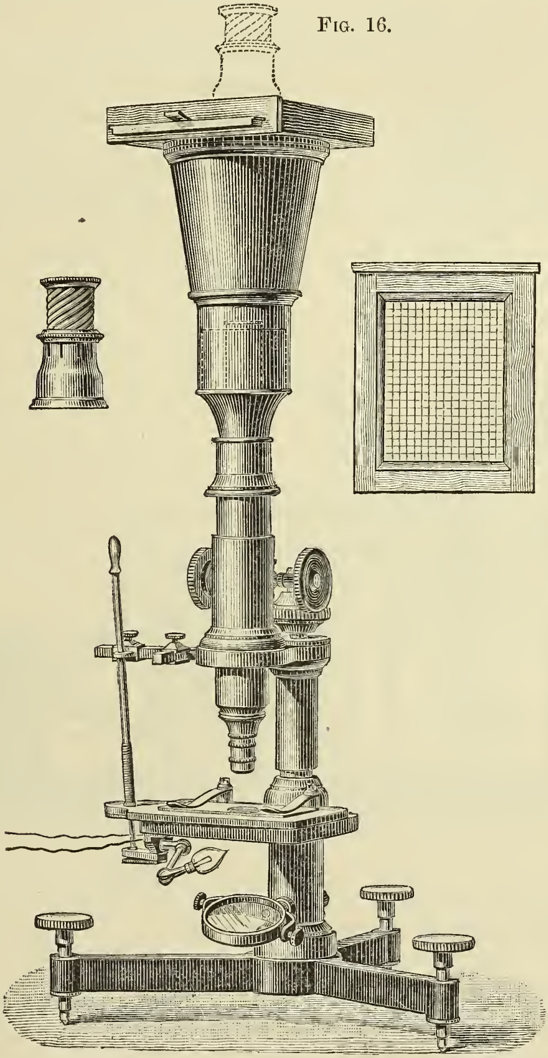
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Duboscq's Photographic Microscope.—The Microscope shown in fig. 16 was devised by M. Jules Duboscq of Paris for obtaining photographs 8 cm. in diameter.

Fig. 16.



* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

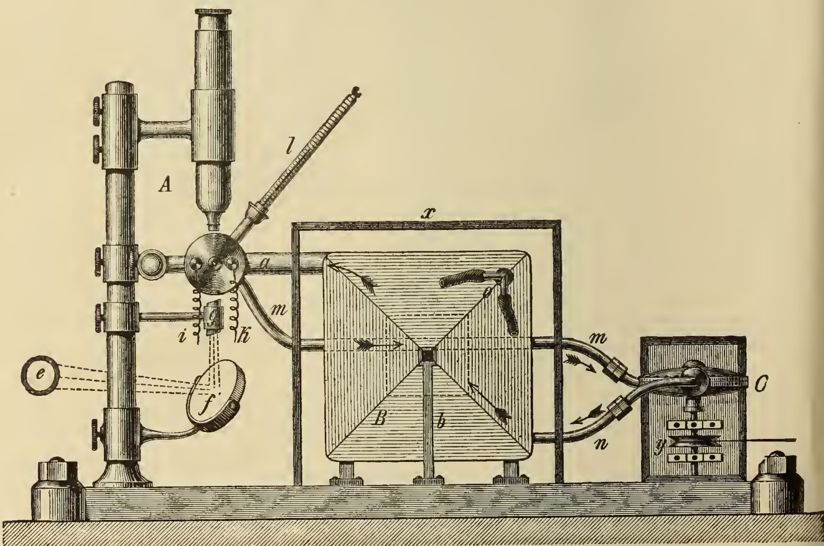
A camera, as will be seen from the fig., slides over the top of the body-tube. The tripod feet of the Microscope are provided with levelling screws, while the movements of the stage are effected by a White lever, which is made of extra length so that it may be close to the milled heads of the coarse-adjustment. A special support for the lever is attached to the cross-arm. A small electric incandescent lamp is attached beneath the stage.

The small fig. on the left is the focusing glass (shown in position by dotted lines on the top of the camera). The fig. on the right is the ground-glass plate, which is divided into spaces.

The instrument is also made with the photographic part independent, and mounted on a slide fitting, supported by a strong cast-iron base.*

Lehmann's Microscope for heating objects at definite temperatures.†—Dr. O. Lehmann has found the Microscope shown in figs. 17 and 18 very serviceable where it is desired to heat an object at definite temperatures, a regular stream of hot liquid being kept up through the vessel containing the preparation by means of a pump. Dr. Lehmann

FIG. 17.



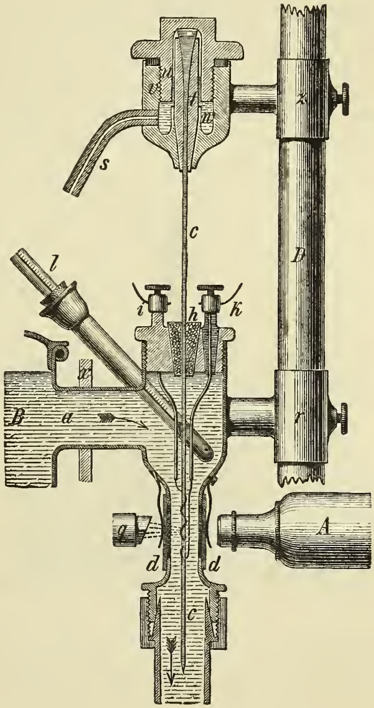
first made use of an ordinary air-pump, in combination with a spacious reservoir, which was put in motion by a gas motor, but in the later form a centrifugal pump is used, as represented (somewhat diagrammatically) in fig. 17. A is the Microscope, whose stand is fastened to the wall in order to avoid oscillations due to the action of the pump; B is the reservoir for the liquid, and C the centrifugal pump. Out of the reservoir B, in which equal distribution of temperature is effected by

* Cf. La Lumière Électrique, xix. (1886) pp. 217–9 (2 figs.).
† 'Molekularphysik,' Band i. (1888) pp. 151–2 (2 figs.).

a stirrer worked by the arm *b*, the liquid passes through a short wide tube *a* into the observation tube, which is shown in section in fig. 18. This tube is contracted and flattened out opposite the objective, and the side walls are cut away and replaced by plate glass *d d*, through which the light from the lamp *e*, after reflection at the mirror *f* and passage through the nicol *g*, can enter into the body-tube A.

The substance under observation is contained in a thin capillary tube *c c*, which passes through a cork *h* in the cover of the observation tube. It is closed below, but terminates above in a funnel-shaped opening. *i* and *k* are two wires, attached to two binding-screws, which transmit the electric current through the fine wire spirally wound round the capillary tube at the position of observation. By the passage of the current the temperature is locally and for an instant considerably raised. One wire *k* is insulated from, while the other is directly connected with, the cover. A thermometer with small bulb close to the capillary tube serves to register the temperature. The hot water or paraffin passes from the tube *a* (fig. 17) into the exhaust tube *m m* of the pump, and from this through the tube *n* back into the reservoir B. To protect the observer from the hot gas-flame, the reservoir is surrounded by a screen of asbestos *x*. The reservoir is provided with a Reichert's temperature-regulator O, which automatically keeps the gas-flame at the right height.

Fig. 18.



The wheel *y* which drives the pump is put in motion by a small gas motor stationed on the ground away from the wall on which the Microscope is mounted. By means of a strap the gas motor also drives the stirrer. For examining under high pressures the capillary tube *c c* can be put in connection with a Cailletet pump by means of the capillary tube *s* (fig. 18), which passes into the small metal reservoir *v*, closed above by the cover *u* screwed on air-tight, and below by the stopper *t*, in which the capillary tube *c c* is fixed with shellac. *t* is so high that it can be fastened after removal of the cover *u*. The open space *w* contains glycerin from the Cailletet pump. The whole is supported by the clamp *z*, sliding on the rod D, which is provided with a second clamp *r* for holding the observation tube, while it is itself

supported by a clamp of the Microscope-stand or is fixed to the wall which supports the whole apparatus.

Lehmann's large Crystallization Microscope.*—Dr. O. Lehmann describes the large Crystallization Microscope which he designed for use where great stability is required. (A more portable form was described in this Journal, 1885, p. 117.) The instrument is shown in figs. 19–21.

For stability the base of the whole is formed of a large heavy cast-iron plate *b b* (fig. 20), which for convenience in height is let into an opening in the table, and rests by means of four levelling-screws upon two strong ledges strengthened by cross-pieces. It is pierced by several holes provided with screw-threads in which fit the different stands and apparatus. On the same ground of greater stability the movement of the body-tube is effected in quite a different manner to that of the ordinary Microscope. The socket which carries it is rigidly connected with the base-plate by a ┌-formed holder (fig. 21). This allows the cross-arm to be very long, which renders more convenient the handling of the object on the stage. Since experiments at high

Fig. 19.

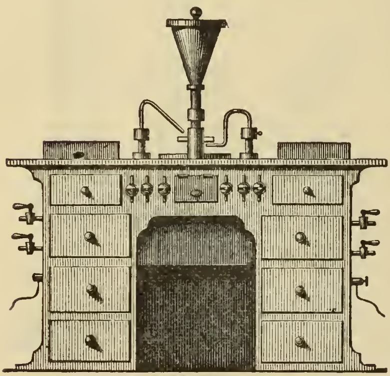
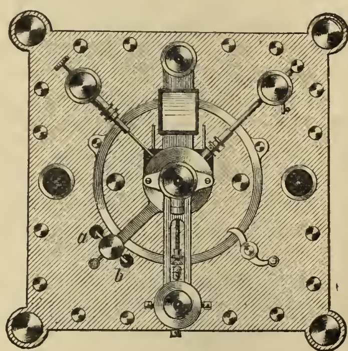


Fig. 20.



temperatures, in which a large flame is used, require a considerable raising of the stage, and consequently a greater height of the body-tube than could be attained by a simple movement in the socket, the ┌-formed holder consists of two parts, viz. the tube, firmly screwed into the base-plate, and the holder proper, which slides tightly in this, and can be fixed in definite positions by means of a steel pin, which is inserted into holes bored through the holder at regular intervals equal to the distance through which the body-tube slides in its socket. The nut is then screwed on to the lower end, and the whole is as firmly fastened as if it consisted of a single piece. For the coarse-adjustment the body-tube simply slides in the socket, but the fine-adjustment is effected by means of a second socket, consisting of two parts, in which

* 'Molekularphysik,' Band i. (1888) pp. 126–33 (3 figs.).

the first moves, though not quite freely. The first socket is provided with a screw-thread, upon which works a collar fastened to the second socket by pins. By turning the collar the first socket is slowly raised or lowered as the adjustment requires. Two spiral springs on the second socket, fixed below, and having their upper ends in contact with a long plate attached to the first socket, prevent backlash between the screws. (Later this was effected by means of a single screw attached to the cross-piece of the holder.)

Another peculiarity of the instrument is the stage, which is not connected with the body-tube, but is carried by a special foot. In the middle of the base-plate is let in a conically-turned toothed ring, which can be rotated by a small toothed wheel. On this ring is screwed a divided circle, which is itself surmounted by a cast-iron plate of smaller diameter, provided with two parallel slits, in which slide the two sides (tapered below) of the horse-shoe which forms the foot of the stage. This motion is effected and measured by means of a micrometer-screw provided with a divided head. The ring as well as the foot are provided on their under side with screws and caoutchouc rings for avoiding backlash. The foot carries a pillar, which supports a plate *a*, bored through, and having on its upper side a conical projection. On this cone rotates a second plate, provided with a slit in which slides a metal piece, bored through and tapered below, to which are attached two short pins, which support the thin circular disc forming the stage proper. The form and size of the stage varies according to the experiment. When a high temperature is required the lenses of the Microscope are protected by a thick copper diaphragm, provided with a small hole. In certain cases this is made hollow and kept cool by a stream of cold water flowing through it. In fig. 20, *a*, *b* are the holes through which pass the tubes conveying the water.

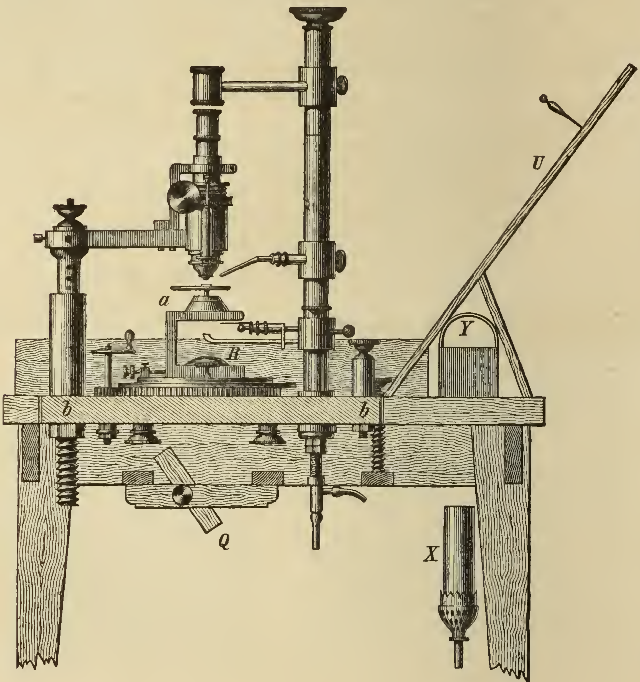
The burner R for heating the object, and the rod carrying the screen of glass or mica for moderating the temperature, are attached at right angles to a hollow metal column, which communicates by a branch tube below with the gas supply, and contains a smaller tube, reaching as far as the attachment of the burner, which conveys from a gas-holder the air necessary for the non-luminosity of the flame. The gas supply is cut off from the burner by a screw stopper at the top of the column. The latter is not screwed into the base-plate, but fits conically into it, and is fastened by a nut and caoutchouc ring only so firmly that it may be easily turned by the hand about its axis. The contact of two arresting pins during the rotation automatically effects the correct adjustment of the burner exactly beneath the opening of the stage.

Polarization can be effected in several ways, either by a bundle of glass plates Q (fig. 21) reflecting to a condensing lens the light from the gas-lamp X, the smoke from which passes off by the chimney Y; or by means of a concave mirror; or finally by a bundle of plates, which receives its light from an adjustable plane mirror. The analysing nicol is carried by an arm which slides on a vertical pillar, and can be clamped in any position above the eye-piece. The pillar in the lower part of its length is hollow, and forms a tube which at about the middle projects outwards at right angles, and is then bent downwards towards the stage with gradually diminishing section. This

tube serves to convey a stream of air for cooling the preparation. The tube is closed, and consequently the air cut off, by means of a conically pointed screw on the opposite side of the pillar.

For measuring extinction angles and angles of crystals, &c., the Microscope is provided with cross wires. In order that the axis of rotation of the stage should pass exactly through the centre of the cross-wires, the cross-piece of the ⌐-formed arm is not rigidly connected with the vertical column, but only by means of a nut screwed

Fig. 21.

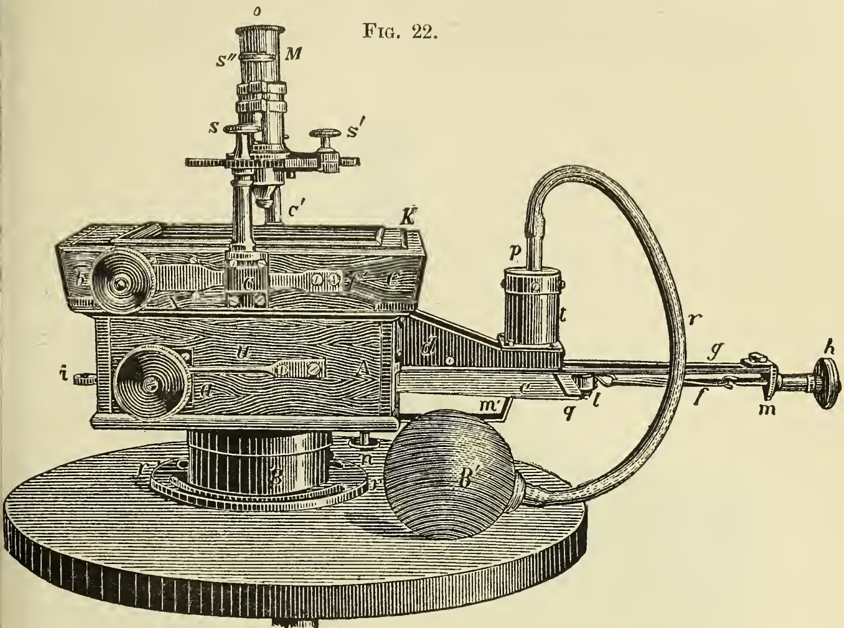


firmly on. The opening through which the spindle of the screw passes is somewhat larger than it, and the latter is square below. Against the faces press four screws set in the cross-piece at angles of 90° to each other. As is seen from fig. 20, the required adjustment can be effected by suitable movement of these. In order to be able to fix the form of the object a drawing-board U (fig. 21) is set up obliquely behind the Microscope, a small three-sided prism being fixed to the eye-piece. Two raised portions on the table serve to support the arm during drawing and observation.

Konkoly's Microscopes for the Cameras of Telescopes.*—Dr. N. v. Konkoly uses a compound Microscope for focusing the image produced

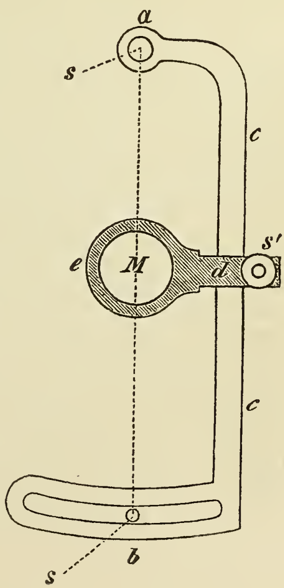
* Central-Ztg. f. Optik u. Mech., x. (1889) pp. 229–32 (6 figs.).

Fig. 22.



by a telescope on the plate of a camera, "as" (he says) "I venture to designate as illusory any other mode of focusing." Such an arrangement is new to us. In the "Universal Camera" the Microscope M is connected with the apparatus, as shown in fig. 22, and the following arrangement is adopted for viewing the different parts of the picture on the plate. To the plate-holder are attached two pillars C C′, which carry an arm *a b c c* (fig. 23) secured in position by two milled heads *s s*. This arm supports the holder *d e* for the Microscope, *d e* slides on *c c* and can be clamped in any required position. At *b* the arm has an arc-shaped slit whose centre is at *a*. The movement of the Microscope along the arm *c c*, combined with the rotation about the centre *a*, enables the observer to cover the whole field of view. In order to bring the focal planes of Microscope and telescope into coincidence, a limited fine motion is communicated to the eyepiece O of the Microscope by means of the screw *s*″ (fig. 23).

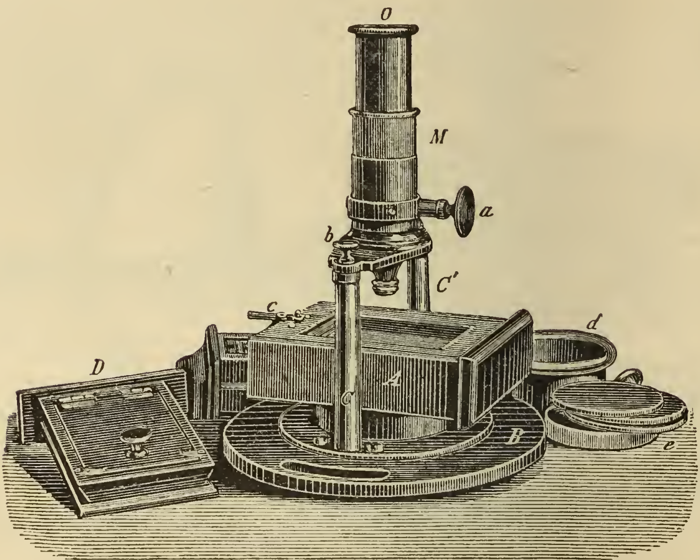
Fig. 23.



In the small camera for small tele-

scopes (fig. 24) the focusing is also effected by a Microscope. The two pillars C C′ carry the fixed bridge b in which the Microscope M is

Fig. 24.



screwed. The objective is a dividing doublet, so that greater play has to be given to the movement of the eye-piece, as one or both are used, and for this purpose a rack and pinion a is applied.

Boys' Microscope Cathetometer.*—Mr. C. V. Boys, in his experiments on the elasticity of quartz fibres both to stretching and to torsion, devised the apparatus shown in fig. 25.

The apparatus (made by Hilger) consists of a Microscope cathetometer shown in the figure at M, which can be made to traverse a vertical slide by means of a fine screw having a micrometer-head, the divisions of which are capable of being read directly to the 1/1000 mm. To the end of the Microscope farthest from the eye-piece is attached the vertical tube T, which carries at its lower end an adjustable arm A, fitted with a clamp C. To the end of a separate bracket is fixed the block a, which supports, by means of a knife-edge, the beam B, which is weighted with a gravity-bob W, and carries on a second knife-edge b the micrometer-scale D, the opposite end of the lever being counterpoised by the adjustable weight P. The fibre to be tested has attached to it a pin at each end to facilitate its being fixed in the apparatus, it being stretched vertically between the scale D and the clamp C.

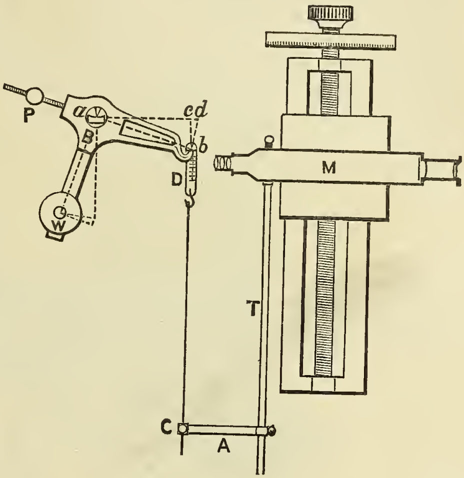
When the micrometer-head is turned, the cathetometer M is lowered, carrying with it the tube T, and thereby putting a tensile strain on the fibre, which draws down the lever B, being itself stretched under the

* Journ. Soc. Arts., xxxvii. (1889) pp. 833–4 (1 fig.).

increasing pull of the lever. The extension of the fibre is measured by the movement of the scale D across the field of the Microscope, and the deflection of the lever B is a measure of the force that is being applied to the fibre, which is obtained by subtracting the amount of extension of the filament from the distance traversed by the Microscope, which latter may be determined with the greatest accuracy by the readings of the micrometer-head.

In adjusting the instrument, the slide is first made vertical by levelling screws, the accuracy of the levelling being determined by means of a spirit-level placed in different azimuths on the top of the micrometer-head. The counterweight P is next adjusted until the knife-edges at *a* and *b* are both in the same horizontal plane, and this adjustment is made when the scale D and the upper attachment pin of the fibre are in their proper position, and the Microscope is focused so as to give a sharp definition of the divisions on the scale. The fibre having been attached to the upper supporting pin and suspended in its place, the length of the arm A is so adjusted that the lower supporting pin of the fibre hangs freely in the axis of the clamp C, which is then tightened, and thus perfect verticality at the commencement of the pull is insured. The micrometer-head is then slowly turned, readings being taken as each division of the scale D traverses and coincides with the cross wire of the Microscope, and the force which thus extends the fibre by each increment of 1/20 mm. is determined in the following way.

Fig. 25.



If the adjustments of the instrument have been made in the manner described above, the moment due to a vertical pull is proportional to the cosine of the angular displacement of the beam, while that due to the gravity-bob and the other portions of the beam varies as the sine of that angle, the actual tensile force applied at D being proportional to the tangent of the inclination of the beam. The vertical distance *c b* is a measure of the sine of the inclination, and when the angular displacement is small this distance is practically the same as the tangent of the angle, and it may be corrected to measure the tangent if very great accuracy be required. The true value of the force corresponding to various values of *c b* may, however, be more easily found by attaching weights to D, and observing by means of the Microscope and scale the weights which produce corresponding deflections.

In this instrument there are two apparent sources of error, which,

however, do not in any way affect the accuracy of the measurement. In the first place, it is evident that as the beam is deflected the point *b* becomes more and more distant from the Microscope, and the pull on the fibre ceases to be vertical, but it must be also noticed that in doing so the scale D is carried out of the focus of the Microscope, which has in consequence to be adjusted by being moved forward to the exact amount which the scale had receded by the movement of the beam, and thus the arm A, carried by the end of the Microscope, is moved forward to an equal extent, the scale comes again into focus, and the fibre becomes again vertical.

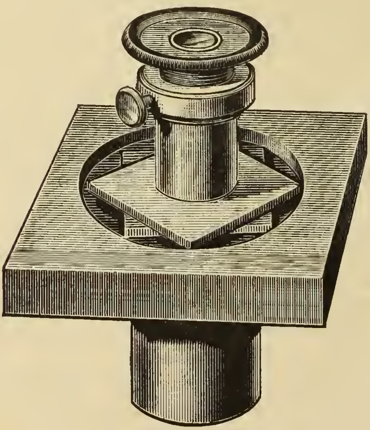
Again, in the case of the tube T being very long, it might happen that the spring of the tube and of the arm A might cause the fibre to appear more stretched than it really is, but the error due to this cause can be perfectly eliminated by finding, in the course of the experiment, the force that is being applied to the fibre, and afterwards placing weights on C until a pull of the same amount is obtained. As a matter of fact, however, with ordinary fibres the further movement of D under these circumstances is not observable.

Poli, A.—**Note di Microscopia. III., Il condensator nei Microscopi.** (The condenser in microscopy.)
Rivista Scient.-Industr., XXI. (1889) Nos. 18, 19, p. 217.

(4) Photomicrography.

Bourdin's Photomicrographic Apparatus.* — After describing Duboscq's large Microscope for photomicrography,† M. J. Bourdin advises microscopists not to neglect the very simple method of producing photomicrographs by means of a small camera, applied in the body-tube when the eye-piece is removed, large enough to permit the use of glass plates of 3 cm. square. The exposure of the sensitive plate is very short, and the magnification being low, it becomes necessary to employ an enlarging apparatus with which one may readily obtain transparent positives as large and as sharp as may be desired, especially by the use of Cowan's chloro-bromide plates which are developed with a solution of 30 grm. citric acid and 20 grm. carbonate of ammonia in 100 grm. distilled water.

Fig. 26.



The small camera in question is shown in fig. 26, and is stated to be recommended by M. Luiz de Andrade Corvo, who is engaged on special investigations of the phylloxera. It is shown together with a focusing lens made by Starsnic, the successor of Vérick.

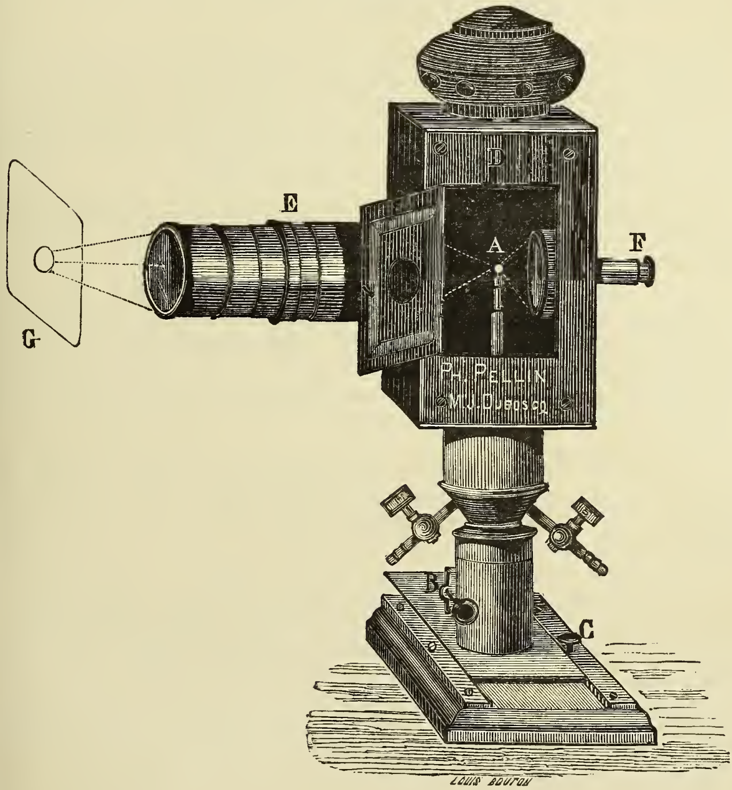
* La Lumière Électrique, xix. (1886) pp. 217–9 (2 figs.). † *Supra*, p. 231.

The focusing lens is adjusted over a glass square, on the underside of which is fixed a fragment of a fly's wing, and the image produced in the Microscope is focused on the plane of the fly's wing. The focusing lens and the glass square are then removed, and a sensitive plate is substituted, being covered by a small cap of obvious construction; the incandescence lamp is then set in action as required, care being taken that no actinic light strikes the sensitive plate except during the required exposure in the Microscope.

Roux's Lantern for Photomicrography.—Dr. Roux has devised the lantern for photomicrography shown in fig. 27.

A small ball of magnesia, 5-6 mm. in diameter, is placed in the lantern D, which is rendered incandescent by an oxy-hydrogen jet. A

Fig. 27.



condenser E concentrates the light on the stage G of the Microscope. Behind the ball is a mirror adjustable by the rod F. The screws at B and C enable the lantern to be centered vertically and horizontally.

Care is required in heating the ball, which must be brought to

incandescence gradually, but when attention has been paid to this point it will last from 60 to 70 hours.

Photomicrography at the Photographic Jubilee Exhibition at Berlin, 1889.*—Dr. R. Neuhauss, who gives his impressions of the photographic exhibition, awards the first place in the microscopical class to the photographs exhibited by the Berlin Hygienic Institute. These are principally the work of Dr. Koch and Dr. Pfeiffer. The latter showed the flagellate micro-organisms, some of which have appeared in the 'Atlas of Bacteriology' of Fraenkel and Pfeiffer. The Institute also showed a very interesting series illustrating the progress of microscopical photography.

Schultz-Henke showed two photographs taken from the same preparation—one with the ordinary dry plate, the other with the eosin-silver plate (spinal cord × 30). The latter photograph showed more details, but it is possible that the dry-plate process was not shown at its best.

Max Hauer exhibited a series of photographs from his 'Atlas of Vegetable Anatomy.' The photographs, which were very large, had been taken with relatively low powers. The size had been attained by means of a large camera or subsequent enlargement of the negative. The defect of this procedure is that the photographs show diffraction lines, a defect possibly inseparable from the method.

The foregoing afford a good illustration of the exhibits, but there are several others mentioned by the author, including an album of his own work.

(5) Microscopical Optics and Manipulation.

Method of Detecting Spurious Diffraction Images.†—Mr. E. M. Nelson writes:—In a previous paper I gave as my opinion that certain alleged diatom gratings, of double fineness and either above or below the original structure, were spurious, because they were caused by the action of an over- or under-corrected Microscope objective on the diffraction-spectra.

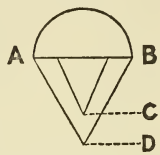
I now show how a test may be applied to determine whether these structures are entities or only diffraction-ghosts. The test will suit equally well other objects which yield a similar arrangement of interference conditions.

Set up the Microscope and adjust tube-length, &c., so that the best view is obtained of say the upper fine grating in *Pleurosigma formosum*, the reality of which is required to be tested. By means of the fine-adjustment the distance between this fine grating and the original coarse grating is accurately measured. The draw-tube of the Microscope is now lengthened one inch or more, and the distance between the two gratings is again measured. If this last measure agrees with the former measure, the grating is in all probability an entity, but if the measure with the long tube exceeds that with the original adjustment, then the fine grating is an optical ghost. In the case of an under-corrected objective, with a fine grating below a coarse grating, it will be necessary

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 273-7.
† Note read 10th April, 1889. Cf. also Journ. Quek. Micr. Club, iv. (1890) pp. 55-6 (1 fig.).

to shorten the draw-tube before the second measure is made. The increase in tube-length need not be so great in the case of a short tube as in a long. In the actual measures I made of the distance between Mr. Smith's upper fine grating and the ordinary well-known grating on *P. formosum* I found the distance between them, at the original adjustment, was 1/8000 in.; an additional inch of tube on the long body increased that distance to 1/5000 in., thus making a difference of nearly 1/13,000 in. A reference to the subjoined figure will make the case abundantly clear. Let A B represent the front lens of an over-corrected objective, C being the objective. Now when a *P. formosum* is placed at C, the spectra of the focus for the central, and D the focus for the marginal portion of the first order only are recombined at the objective conjugate, consequently only the original coarse structure is seen. Let, however, the focus be raised so that the valve is placed at D, then the spectra of the second order only are united at the conjugate, and a grating of double fineness is seen. The movement of the objective gives, of course, an irresistible idea that the fine grating is above the coarse. The effect of lengthening the tube is to increase the over-correction of the objective, i. e. the distance between C and D, and consequently the distance between the fine and coarse gratings.

Fig. 28.



Let me put it in another way: when there is, say, an over-corrected objective on the Microscope, it is just the same as if there were two separate objectives in a rotating nose-piece: the one, a narrow-angled lens of short focus, which is only capable of resolving the coarse grating of, say, 25,000 per inch; the other, a wide-angled longer-focused objective with its centre stopped out, which exhibits the same grating as possessing double fineness, viz. 50,000 per inch. In such a case no one would have been led astray, as an alteration of focus would have been expected, but because all this occurs in one and the same objective, a confusion has arisen.

It is for those who deny the effect of diffraction in the production of the Microscope image, and those who insist on the reality of structures which are not consonant with that theory, to explain why an alteration of one inch in tube-length nearly doubles the distance between the gratings.

Method for measuring the Spherical and Chromatic Aberration of Microscope Objectives.*—M. C. J. A. Leroy remarks that the principle of his method is similar to that which enabled Foucault to put in practice his method of "retouches locales." The surface of the objective, observed through a small hole in a screen is seen illuminated only in the part traversed by the rays isolated by the hole. When the object is a monochromatic luminous point, and the small hole is on one side of the axis, the part illuminated is on the same side or the opposite, according as the corresponding rays cut the axis in front of or behind the plane of the small hole. If the latter be displaced transversely the limit of the bright zone will be displaced, under the same conditions, in

* Comptes Rendus, cix. (1889) pp. 857–9.

the same direction (direct) or in the opposite (inverse). Accordingly, if the observer move along the length of the pencil, so long as he is in front of, or beyond the extreme points of crossing of the rays, the path of the light in the whole extent of the displacement will be either direct or inverse. On the other hand, throughout the extent of the zone limited by these extreme points, there will be simultaneously direct and inverse paths for a certain number of positions of the small hole during a transversal displacement.

The study of chromatic aberration was made in the same manner, the bright regions presenting the colour of the rays isolated by the small hole when white light was used.

The longitudinal aberration proving very troublesome to measure, owing to its enormous extent, the author confines himself to the transverse.

The object was a luminous slit, traced with a sharp razor in a silver layer deposited on a glass plate, and had a width of from 0·005 mm. to 0·0025 mm. The slit was covered by a cover-glass. The small hole, having a diameter of 0·8 mm., was displaced perpendicularly to the slit, and the displacement was read on a scale giving 1/10 mm. The Microscope was adjusted so that the image was clearly defined in the plane of the small hole, whose distance from the slit, placed on the stage, was always the same, 0·20 mm.

The image was generally decomposed into two parts, one with rays coming from the marginal zone of the objective presenting an aberration in a determinate direction, the other, corresponding to the central zone, presenting an aberration in the opposite direction. In subtracting from the total displacement (between the limits of appearance and extinction of the light) the displacement due to the central zone, the same result was always obtained as in taking account of the dimensions of the slit and hole measured directly.

The objectives of the best makers of France and Germany were studied, and gave measurable spherical aberration varying from tenths of a millimetre to several millimetres. In measuring the spherical aberration, a coloured glass was placed over the small hole; for the chromatic aberration white light was used, and its value was judged by the intensity of the variations of the tints. Nearly all the objectives had sensible chromatic aberration, but many were found in which it was scarcely perceptible, and in some, constructed simply of flint and crown glass, it was quite inappreciable.

The author concludes, therefore, that the problem of achromatism may be considered as solved, but that that of aplanatism is far from being so. For the improvement, therefore, of objectives, the correction of the spherical aberration must be chiefly kept in view.

(6) Miscellaneous.

Dr. Hudson's Presidential Address.—The 'Times' of the 18th February contained the following leading article on this Address.

"An address such as the President, Dr. C. T. Hudson, delivered before the Royal Microscopical Society at its Annual Meeting last week is as surprising as it is delightful. All science has a tendency to grow more and more technical and elaborate. So complicated become

its processes, that they exceed the powers of all who cannot devote their lives to it. The details increase so constantly in number and variety that it is compelled to partition itself into infinitesimal provinces. Its mere language and vocabulary distract by their immensity and peculiarities. None but professed students are any longer able to master the diction and the classifications, which are perpetually being changed. The literature on any and every department follows the same rule of crabbedness and bulk. Its publications are too costly for the majority of pockets, and particularly for those which have other demands upon them. Intending naturalists have the authority of the President of the Microscopical Society for believing that all these impediments to the pursuit are superfluous and erroneous. The instrument from which the association derives its name might have been supposed to be principally responsible for the modern banishment of a popular character from inquiries into natural history. Dr. Hudson protests against the injurious suspicion, and deprecates earnestly the practices of professors of science in which it has originated. Specialists, he declares, are enemies against whom war should be waged. Natural history does not need, in his judgment, the uncouth terminology which is the bane of monographs. A host of creatures would, he is persuaded, live more comfortably within the common species, in which of old they congregated, than penned, as now, into separate little enclosures. The one essential for a naturalist is joy in the investigation of the wonders of life; and the freest cultivation of the propensity to indulge the pleasure is equally requisite for the progress of the true science of natural history. Other sciences are backed by their utility. On them arts are founded which ward off material dangers, or serve material interests. The structure of civilization, and most of the conveniences of human existence depend on the principles they embody. Dr. Hudson sees little of this practical bearing in the study for which he pleads. Though a few branches, especially researches into the minutest forms of life, may, he acknowledges, be of the profoundest consequence to human health and prosperity, in general the knowledge of natural history must be its own final reward. For the attraction of recruits to its camp it will, as hitherto, have, he thinks, to rely chiefly on the delight it yields. He is seriously afraid that the emotion may be choked, stifled, and killed before it has had a chance of maturing into a habit, by the exasperating resolve of specialists to encompass the whole subject with an atmosphere in which none but themselves can breathe.

This is a very grave indictment to proceed from the learned recesses of the Royal Microscopical Society. Its President based his remarks on the stumbling-block interposed by the caprices of classification, the addiction to technical terms, and the multiplication of species, to the enrolment of volunteers in the army of naturalists. Their real importance rests rather upon the degree to which the disposition he attacks is adverse to the advancement of science itself. Specialists would not be afflicted if they were left alone in their pursuit. They are inclined to resent and not to court the company of amateurs. They feel the eager inner enjoyment of their study which Dr. Hudson regards as the mainstay of the whole. To them the changes in classification are substantially necessary. Every fresh subdivision for which they can invent a

plausible excuse is for them an absolute enlargement of the territories they severally occupy. To a certain extent they probably could defend themselves successfully against their present critic. Definitions and frontier lines laid down a generation ago have been superseded and overridden by the fruitful discoveries of late years. The kingdom of nature has been found to be an agglomeration of a vast multitude of realms within realms. The new technical vocabulary in which it is described has had to be expressly manufactured to name orders of existence revealed only after the elder terminology had encrusted itself with a confusing significance. Partly it has been rendered indispensable by the demand of fellow workers in different regions of the globe for a common tongue. Melancholy as is the conclusion, and reluctant as everybody must be to come to it, the ancient simplicity and stability of scientific nomenclature are, it is to be apprehended, gone beyond recall. It does not follow, therefore, that the ponderous intricacy and restlessness of the system installed in their stead, of which Dr. Hudson complains, can prove any sufficient justification. A cry has been raised for the establishment of a tribunal to create a fair and uniform standard of judicial pains and penalties. In the world of science a Court is as much wanted for the revision of the vocabulary and classifications introduced by a legion of discretionary scientific jurisdictions. Formerly, when the field of natural science was virtually undivided, the terminology had to submit to a measure of central control. A Linnæus or a Cuvier would sanction or disallow. At present the distribution into an indefinite medley of special groups has given to the workers on them an autonomy they are not invariably qualified to exercise. Though it is too much to hope for a return of the golden age when naturalists spoke in a tongue understanded of the people, and species were not continually splitting off under the disintegrating operation of the Microscope, at least there ought to be some sort of warranty against a repetition in natural science of the experiences of the Tower of Babel.

That would be for the benefit of specialists themselves. The unlicensed fabrication of terminologies and classifications cannot be agreeable to any of them, unless when they are personally engaged in the process. For the sake of the outside commonalty of persons simply endowed with delight in natural history, to whom Dr. Hudson was addressing himself at King's College, it is much to be wished that his professed brethren would give more encouragement than they have given of late to the pursuit in its older form. Without disrespect to the physiological aspects of the study, it is to be regretted that the view which treated it as primarily observation of the ways and usages of the stages of animated nature below the human has fallen comparatively into neglect. The President of the Microscopical Society has exhorted its members to prepare themselves for the profitable employment of microscopical investigation by diligent attention to living animals, their beauty and their actions. Nothing can be more astonishing than that science, with all its toil, has as yet discovered so few of their characteristics as sentient and moving creatures. How they exist, the arts by which they catch their prey or elude capture, the secret of their confidence or spite, the laws of their affections, their amusements, their

sense of humour, and their humours, their cleverness and their stupidity, are problems still for the most part remaining for natural history to answer. Its students will find but scanty information on them throughout the entire stately library of science. The system thus inculcated was followed by Gilbert White. Old fashioned as it appears now, it may well be that the path it points out leads more directly than those which modern philosophy prefers to the solution of the deep mysteries of the gradations of animate being and intelligence. With relation even to utility, which Dr. Hudson is ready to give up as off the naturalist's beat, there are questions fully worthy of his consideration. Miss Ormerod has shown that natural science has its uses for agriculture. Beside her particular charges there are other insect pests in plenty of which the world could be rid if naturalists would take the trouble to learn their habits. Where, for instance, is there a martyr of science willing to devote himself to a thorough search into the manners and morals of black-beetles, the things they love, and the things they hate? A naturalist who taught London to understand, and rout and extirpate, them would deserve any metropolitan honours he chose to ask. The County Council might feast him as lavishly as the City Corporation, and not the meanest ratepayer would grudge the cost of the entertainment."

New Italian Microscopical Journal.—We welcome the appearance of the first and second fascicles of the *Bollettino della Società Italiana dei Microscopisti*, the organ of the Italian Society of Microscopists. The Society, which embraces the whole of Italy, was founded on the model of the corresponding Societies in England and America; and its *Bollettino* will contain papers on the investigations of microscopists on animal and vegetable organisms, on petrology, on bacteriology, especially in its pathological relations, and on the structure of the Microscope and microscopical appliances. In addition to a number of minor articles and notes, the first number contains important papers on a new genus of green Algæ, and on two new genera of fossil Foraminifera, on a rock containing leucite from Etna, on the function of calcium oxalate in leaves, and two important contributions to bacteriology.

Prof. Frey.—The death is announced of the famous Zurich professor, Dr. Heinrich Frey, one of our Honorary Fellows since 1879, who after forty years of active work, retired only a few months ago. Frey was born at Frankfort-on-the-Main, June 15th, 1822, and at twenty-five years of age had qualified, by brilliant preliminary studies, for the post of *Docent* in the University of Göttingen. In 1848, the Medical Faculty of Zurich nominated him Extraordinary Professor, and in 1851 Ordinary Professor. In 1855 he undertook the Professorship of Medicine in the Polytechnic of Zurich, and also the post of Director of the Microscopo-Anatomical Institute. From 1854 to 1856 he also filled the position of Rector in the "Hochschule." His researches in physiology were published in works which have been translated into nearly every European language, and are valued as models of lucid exposition. His book 'Das Mikroskop' has passed through eight editions, and was translated into English by Dr. G. R. Cutter. Prof. Frey was also an accomplished entomologist.

Microscopy at the Paris Exhibition.—The 'Annales de Micrographie' has concluded * a series of brief articles on the Microscopes and apparatus at the Paris Exhibition of 1889, which, with those of Dr. Pelletan in the 'Journal de Micrographie,' and of Mr. Mayall in this Journal, constitute, so far as we know, the only record of this section of the Exhibition.

Price of the new Objective of 1·63 N.A.—We understand that the price of this objective is not 10,000 francs or 400*l.*, but 1000 francs or 40*l.* An extra nought seems to have crept into the original report on the subject.

β. Technique.†

(1) Collecting Objects, including Culture Processes.

Friedländer's Microscopical Technique for Clinical and Pathological Purposes.‡—Dr. C. J. Eberth has just published the fourth edition of C. Friedländer's well-known work on microscopical technique. The author has not only revised the whole, but made considerable improvements. For example, Section II., which treats of the microtome, is much enlarged, and Section III., dealing with the methods of preparation, such as hardening, imbedding, &c., has evidently had a good deal of pains bestowed on it. Some of the sections, e. g. Section V., "Observing Living Tissues," are unaltered, and some sections appear to contain views of doubtful value, but on the whole the work is one which can be recommended to the bacteriologist and the pathological anatomist.

Artificial Cultivation of Ringworm Fungus.§—Dr. H. L. Roberts' observations, and his conclusions from a series of cultivation experiments made on *Trichophyton tonsurans*, are very interesting. A portion of scalp affected with ringworm was first cleansed with a 1 : 200 solution of corrosive sublimate. The broken hairs were then removed with forceps, and their bulbous ends having been snipped off, the pieces were dropped into flasks containing saccharine infusion of malt and alkalinized beef-broth, and incubated at 30° C.

The fungus was observed to have started developing in 24 hours, and in three or four days from the formation of the primary colony secondary deposits were visible. If the colonies rose to the surface, they speedily became covered with a white powder. On microscopical examination the mycelium was found to be regularly septate, and filled with a granular protoplasm. When development takes place in air, the mycelium becomes finer, the segments are small, and the terminal fruit-bearing filament may end in an ampulla. The spores are pear-shaped, are attached by their narrow end, and are sometimes seen to project from the ampullæ.

Inoculation experiments on guinea-pigs, and on the author's own

* Ann. de Micrographie, ii. (1890) pp. 168–71.

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

‡ 'Friedländer's Microscopical Technique,' 4th edition revised by C. J. Eberth, Berlin, 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 72.

§ 'British Journal of Dermatology,' i. (1889) pp. 359–65 (3 pls.).

arm, gave the usual characteristics of ringworm. The author concludes that *Trichophyton* is "a fungus able to vary its form and activity according to the physical and chemical properties of the soil on which it grows." As a saccharine medium has been found to be the most favourable soil, it follows that the animal skin is unsuitable; hence "the ringworm fungus vegetates, but does not develope" there.

Behrens, W., Kossel, A., u. Schiefferdecker, P.—**Das Mikroskop und die Methoden der mikroskopischen Untersuchung. Bd. I. Die Gewebe des menschlichen Körpers und ihre mikroskopische Untersuchung.** (The Microscope and the Methods of Microscopical Investigation. Vol. I. The Tissues of the Human Body and their Examination by the Microscope.) Braunschweig (Bruhn), 8vo, 1889, 315 pp., 193 figs.

Boneval, R.—**Nouveau guide pratique de technique microscopique appliquée à l'Histologie et à l'Embryogénie. Suivi d'un formulaire indiquant la composition des réactifs employés en anatomie microscopique.** (New Practical Guide of Microscopical Technique applied to Histology and Embryology. Followed by formulæ for the reagents employed in Histology.) 8vo, Paris, 1889, 21 figs.

Davis, G. E.—**Practical Microscopy.** New ed., Philadelphia (Lippincott), 1889.

Ramon y Cajal, S.—**Manual de histología normal y de técnica micrográfica.** (Handbook of normal Histology and Microscopical Technique.) Valencia (Ostega), 4to, 1889, 692 pp., 203 figs.

(2) Preparing Objects.

Mode of Studying Free-swimming Larvæ.*—Dr. G. C. J. Vosmaer recommends that free-swimming larvæ should be put into a glass, the bottom of which is covered by a loose, thin sheet of collodium; to this they attach themselves readily. The spot to which a larva is attached can be cut out under water whenever required. The collodium is transparent and easily cut with the larva. If it is desired to examine the base, the collodium may easily be dissolved. The preservative fluid recommended is that which Kleinenberg used for *Lopadorhynchus;* this gives by far the best results, cilia, for example, being hardly shorter than in the living animal.

Examination of Renal Organ of Prosobranch Gastropoda.†—M. R. Perrier has used three methods in examining the renal organs of Prosobranch Gastropods. The examination of living tissues, teasings, and serial sections have been the methods employed. The great difficulty to overcome has been the extreme alterability of the tissues, and the delicacy of the renal cells has been noticed by all observers. Under the influence of whatever reagents, the epithelium becomes completely destroyed unless sufficient precautions are taken. Owing to the changes which are continually taking place it is necessary to at once arrest the secretion. Ordinary fixing reagents, and particularly osmic acid, are of no use for this purpose; indeed, they seem to make the secretion more active. The best results have been obtained with acetic or picric acid, or, still better, a mixture of the two; picro-sulphuric acid has also been of use. The organ must be cut out of the body as rapidly as possible, plunged for one or two minutes into a 1 per cent. solution of osmic acid, washed rapidly, and left for some hours in a mixture of picric and acetic acids. It must then be put in 70 per cent. alcohol for as long a period

* Tijdschr. Nederl. Dierk. Ver., ii. (1889) p. 289.
† Ann. Sci. Nat. Zool., vii. (1889) pp. 71–9.

as may be wished, when it is ready for sectionizing. Sections were made with one of Dumaige's automatic microtomes, which gives the most excellent results. When fixed, the specimen was stained with picrocarminate of ammonia, which is the best of all; after one or two days in a solution of this material, the preparation must be gradually hardened in alcohol of 70°, 90°, and 100°—one day in each, fresh absolute alcohol being applied two days in succession. To this last fluid methylene-blue may be added, as it will stain the protoplasm and muscles, while having no influence on the nuclei. The object should next be successively placed in cedarwood-oil, paraffin with this oil, and pure paraffin. As the renal cells of Molluscs are very small, the sections should be extremely fine, and it is well not to have them more than 1/400 mm. in thickness.

When about to be placed on the slides it is well to make a limpid solution of 2 or 3 parts of gelatin in 100 parts of water; this, after careful filtration, should be placed on the slide, and the rows of sections will be found to swim in it; they can then be arranged as desired. The slide must then be placed on a plate warmed to about 40°, but not hot enough to melt the paraffin. At this gentle heat the sections become spontaneously extended in the gelatin, and all the creases in them will be found to disappear. The gelatin may now be left to dry. When the gelatin is dry, the paraffin may be easily dissolved away and the sections mounted in balsam.

Mode of Preparing Ova and Embryos of Blatta Doryphora.*—Mr. W. M. Wheeler used the following method in his studies on Insects' eggs:—The ovarian ova in all stages up to maturity were dissected out in normal salt solution, and hardened for fifteen minutes in Perenyi's fluid. They were then transferred to 70 per cent. alcohol, which was changed several times at intervals of an hour, and were finally preserved in alcohol of the same strength. When stained with borax-carmine and sectioned, the yolk retained none of the red stain, while the chromatin of the nucleus shone out as a glistening deep red spot. Perenyi's fluid rendered the chorion of the mature ovarian egg pervious to borax-carmine. Hardening in a saturated aqueous solution of corrosive sublimate gave good results with young ovarian eggs. Oviposited eggs were killed by placing the capsules in water slowly heated to 80°–90° C. The two lips of the crista of the capsule were then separated by the aid of fine forceps, and pieces of the walls torn away, till the eggs could be easily pushed out of the compartments formed by their choria. The ova thus isolated were either transferred directly through 35 per cent. (10 min.) to 70 per cent. alcohol, or they were left for 15 minutes in Kleinenberg's picrosulphuric acid, and after repeated washing in 70 per cent. alcohol, preserved in alcohol of the same strength. Both methods gave equally good results.

Though he has succeeded in dissolving the chitin of the ootheca with sodium hypochlorite, the method of tearing off the walls after heating to 80° C. gave such satisfactory results that he adhered to it through his work. He has found Grenacher's borax-carmine in every way the most expedient and reliable staining fluid. Eggs and embryos, up to the time

* Journ. Morphology, iii. (1889) pp. 292-3.

when the cuticle developes, were stained before imbedding in paraffin; the sections of other embryos were stained on the slide after attaching them with Mayer's albumen fixative. Beautiful results in preparation were obtained by heating the eggs to 80° C. for 10 minutes in Kleinenberg's picrosulphuric acid (with 3 volumes of water), and preserving in 70 per cent. alcohol. By this process the envelopes, which in the fresh egg adhere closely to the yolk, dilate and stand off from the surface of the egg, and except in the very youngest stages can be rapidly and easily removed with the dissecting needles.

Investigation of Derostoma unipunctatum.*—Herr K. Lippitsch found his specimens of this worm preserved in sublimate, osmic acid, or osmic-acetic acid. The staining reagents used were hæmatoxylin, picrocarmine, and alum-carmine; osmic acid is not a good preservative, as it causes deformations of the epithelium, but sublimate is, as with other Turbellaria, very good. After treatment with hæmatoxylin for two or three hours all the glands become very clear, and the same reagent is good for the nervous system when osmic-acetic acid has been previously used. Twenty-four hours' stay in picrocarmine is useful for the study of the epithelium, nervous system, musculature of the pharynx, and connective tissue. Alum-carmine is also to be recommended.

Preparation of Horny Teeth of Batrachian Larvæ.†—Herr E. Gutzeit preserved his larvæ in 0·2 per cent. chromic acid or in sublimate, and afterwards placed them in alcohol; they were stained *in toto* by hæmatoxylin or picrocarmine. Paraffin was generally, and soap only rarely used as imbedding material. The sections were attached by oil of cloves and collodion, and Canada balsam was added. Wickersheim's fluid or Müller's solution was used for macerating purposes, and preparations so made were preserved in glycerin-gelatin.

Production of Colourless Spirit-preparations.‡—Herr H. de Vries proposes the following process for this purpose:—By adding two parts by volume of strong hydrochloric acid to 100 parts of alcohol, the production is prevented of brown pigments in the parts of plants which are plunged when living into the mixture; and the preparations thus obtained are much more beautiful than by the ordinary method. Even plants in which the brown pigment is very conspicuous, such as *Orobanche*, become white in this mixture; the only case of failure was with *Aucuba*, older portions still retaining their brown colour, while younger portions became quite white.

Observation of Nuclear Division in Plants.§—Prof. D. H. Campbell recommends for this purpose the pollen-mother-cells of *Allium canadense* or of *Podophyllum peltatum*, taken from a bud. They should be crushed or teased out into a mixture of equal parts of acetic acid and water, when the pollen-mother-cells are at once recognizable by their thick colourless walls; if they are already in the required stage of division, they may be stained by acetic methyl-green or gentian-violet, made by adding a sufficient quantity of a saturated alcoholic solution of gentian-

* Zeitschr. f. Wiss. Zool., xlix. (1889) pp. 148–9. † T. c., p. 65.
‡ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 298–301.
§ Bot. Gazette, xiv. (1889) p. 199.

violet to a mixture of two parts of distilled water and one of acetic acid. If a drop of this mixture is added to the preparation containing the pollen-cells, the nuclei will almost instantly be coloured a deep blue-purple, while the cell-protoplasm remains colourless and entirely uncontracted. The staining fluid may now be removed by blotting-paper, and the preparation mounted in dilute glycerin. Specimens prepared in this way, especially when first made, show all the finest details of the structure of the nucleus.

Fixing the Spores of Hymenomycetes.*—Inasmuch as a solution of Canada balsam in turpentine-oil has a tendency to oxidize and become cloudy after having been prepared for a year, Prof. C. O. Harz now proposes to substitute lavender-oil or petroleum for the turpentine-oil.

Direct Impressions of Plants.†—M. Bertot obtains direct impressions of plants in the following way:—The plant is first saturated with oil by placing between pieces of paper soaked in oil, and an impression of it is then obtained in oil on white paper. The paper is now treated with graphite, and the oily places are thus turned black and a perfect impression of the plant obtained. The paper is now freed from excess of graphite by wood-ash. To fix the image, powdered colophone is mixed with the graphite, which sinks into the paper when slightly warmed. Spots which sometimes appear upon the paper may be removed by soaking the paper in an aqueous solution of tragacanth.

Demonstrating Tubercle Bacilli.‡—Dr. Bliesener recommends the following method as being very expeditious:—The cover-glass, having been dried in the air and passed thrice through a flame, is placed with the sputum layer uppermost on a metal plate about 5–6 cm. square fixed to a stand so as to keep it horizontal. Five or six drops of carbolic fuchsin are then dropped on with a pipette and the metal plate warmed until the fluid begins to evaporate. The flame is then removed, and then the cover-glass, after remaining on the plate for about a minute, is washed with water previous to its being dropped on the acid contrast fluid (methylen-blue $1 \cdot 5$, H_2O 100, H_2SO_4 25). In about fifty seconds it is removed, washed in water, and examined.

The foregoing staining procedure, if combined with Biedert's method of examining sputum, is said by the author to be very satisfactory. Biedert's method consists in boiling the sputa with water to which some drops of caustic soda have been added.

Agar-agar as a Fixative for Microscopical Sections.§—M. A. Gervis, who recommends agar-agar as a medium for fixing sections, imbedded in paraffin, on slides, proceeds as follows:—Half a gramme of agar having been cut up into small pieces, is allowed to soak for some hours in 500 grammes of distilled water. When it has swelled up it is boiled for about a quarter of an hour in order to completely dissolve the agar.

* SB. Bot. Ver. München, Nov. 11, 1889. See Bot. Centralbl., xl. (1889) p. 345. Cf. this Journal, 1889, p. 461.

† Bull. Soc. Linn. Normandie, ii., 1887–8 (1889) pp. 442–5. See Bot. Centralbl., xl. (1889) p. 285.

‡ Deutsche militärarztl. Zeitschr., xviii., pp. 406–9. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 72–3.

§ Bull. Soc. Belge de Microscopie, xv. (1889) pp. 72–5.

When cold the liquid is filtered through a fine cloth and kept in stoppered bottles. A small piece of camphor to prevent the development of micro-organisms may be placed in each bottle. The slides must be perfectly clean, and should be boiled in water acidulated with hydrochloric acid, and, having been rinsed in distilled water, are dried with a perfectly clean cloth. Upon the slide is brushed over a layer of this fixative, excess of which is immaterial, as it is easily removed later on.

The sections are then arranged on the slide with a fine brush. Directly this is finished the slide is gently heated over a Bunsen's burner. The paraffin is to be softened only, and not melted. Any unevenness or folds in the sections at once disappear. As the slide cools the paraffin sets; and now if there be too much of the fixative, it may be removed by just sloping the slide so as to drain it off. The fixative must now be allowed to dry thoroughly, and it is best to leave the slides just covered from dust, &c., until the next day.

The paraffin is then dissolved in warm turpentine or in chloroform, and these last removed by means of a little strong spirit. If the preparations have been stained before imbedding, nothing remains to be done but to dehydrate the section in absolute alcohol, clear up in oil of cloves, and mount in balsam. If not stained, the slide is placed in the staining solution, and when withdrawn goes straight into spirit.

The advantages of this method are that the fixative is liquid at ordinary temperature, the sections are easily arranged, all folds and creases are completely removed, and no air-bubbles trouble the manipulator. As the fixative is an aqueous solution, the cells of vegetable preparations swell up in it to their original size. When properly dried, the fixative is insoluble in all reagents and alkalies, &c., except water, which causes it to swell up and tends to loosen it from the slide. Unless the agar-layer be thick, the fixative does not become coloured in the staining solutions.

The preparations may be mounted either in balsam or glycerin.

(3) Cutting, including Imbedding and Microtomes.

Florman's Method of Imbedding in Celloidin.*—Dr. S. Apáthy raises several objections to the method of celloidin imbedding advocated and practised by Florman. The principles of the two methods are diametrically opposite. Florman advises imbedding in glass capsules in a thin solution of celloidin, and then solidifies by allowing the slow evaporation of the solvents, ether and alcohol. Dr. S. Apáthy's method consists in transferring the objects to solutions of celloidin of increasing thickness, and in only allowing evaporation of the ether-alcohol when the thickest solution has been reached. The objections to Florman's method seem chiefly to consist in the possibility of delicate objects being distorted, owing to the contraction of the celloidin, and also disarranged; in the long time required for imbedding; and in the fact that the undermost layer is usually left behind when the mass is extracted from the capsule.

But it is possible that the two microtomists are in the habit of dealing with different materials; the one with delicate objects, the

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 301–3.

structure of which becomes materially altered by the slow contraction of the imbedding mass, and the other with material which has been previously well hardened and is in itself dense, so that the defects alluded to are unperceived.

(4) Staining and Injecting.

Kühne's Methylene-blue Method of Staining Bacteria.*—This method is especially recommended for staining bacteria in sections of animal tissues, although it is equally applicable to cover-glass preparations made from fresh tissues. The usual differences in the method of staining cover-glass preparations and sections are to be observed.

The advantages to be derived from this method are found in its being applicable to all known forms of bacteria. It eliminates the use of special stains for certain micro-organisms where only their presence is to be demonstrated. It possesses superior powers of differentiation between bacteria and the tissue elements. The method as given by Dr. Kühne † is essentially as follows.

The sections which have been cut by the ordinary method (although Dr. Kühne recommends the freezing microtome for this purpose), are transferred directly from alcohol to a watch-glass containing carbol-methylene-blue. (1) The sections should remain in this staining fluid for about half an hour; some bacteria, such as the bacillus of leprosy, requiring a longer time, one to two hours. If the sections remain in the staining fluid for a much longer period, the differentiation between the germs and tissue-elements becomes more difficult.

After staining for the desired length of time, the exact period of which will have to be determined by test experiments for the different germs and tissues, the sections are rinsed in clear water and then placed in acidulated water (2) until they become a pale blue. They are then washed in a weak watery solution of carbonate of lithium (3), and again placed in clear water. This part of the procedure is very important, and to insure good results should be performed with much care. The time that the sections should remain in the decolorizing agents varies with their thickness, histological structure, and the intensity of the stain, making it impossible to give any definite rule to be followed. The degree of decolorization can be very nearly determined at any moment by moving the sections about in the fluid by means of a glass rod. If the section is very thin, or if there are other reasons why it should take up very little of the stain, a momentary immersion in the acidulated water is sufficient. In all cases where the staining process is completed the sections should have a pale blue colour, for if darker, the over-stained corpuscles and cell-nuclei of the tissue would obscure the bacteria. In cases where it is feared that too much colour has been removed in the acid a drop of a saturated watery solution of methylene-blue should be added to the lithium-water.

After the sections have remained in the water for some minutes they are dehydrated in absolute alcohol in which, in difficult cases, a little methylene-blue may be dissolved, and then transferred to a watch-glass

* Amer. Mon. Micr. Journ., x. (1889) pp. 259–60.

† Kühne, 'Praktische Anleitung zum mikroskopischen Nachweis der Bakterien im tierischen Gewebe,' p. 15.

containing methylene-blue anilin oil (4). The sections can be dehydrated in the alcohol without injury to the stained bacteria. The sections are now transferred to pure anilin oil, in which they are rinsed and then placed in some essential oil, as turpentine, where they should remain for two minutes. In order that the sections should be perfectly cleared they are transferred from the turpentine to xylol, from which they are mounted in balsam. It is recommended that the sections should pass successively through two xylol baths in order to secure absolute elimination of the anilin oil. The xylol may be used for a considerable number of sections.

Dr. Kühne employs a glass rod for transferring the sections from one solution to another instead of the ordinary spatula or section-lifter. The end of a small glass rod is immersed in the fluid containing the section, which is allowed to fold itself over the rod, and in this position it is lifted from the fluid. The end of the rod is then gently immersed in the second liquid, where the section unfolds itself from the rod and floats upon the surface. In this way the danger of tearing the section is diminished and the time required for their transfer from solution to solution is much shortened. This is an important consideration where a large number of sections are to be stained.

(1) *Carbol-methylene-blue.*—This is prepared by grinding in a mortar 1·5 grams of methylene-blue with 10 ccm. of absolute alcohol until dissolved; 100 ccm. of 5 per cent. carbolic acid are gradually added and thoroughly mixed with the alcoholic solution. The resulting liquid is preserved in a well-stoppered bottle, until used. When only a small quantity is to be employed it is better to prepare only a half, or a quarter even, of the above quantity, as its staining power is diminished by long standing. It should always be *filtered* before using.

(2) *Weak acidulated water.*—To 500 ccm. of distilled water add 10 drops of nitric acid.

(3) *Lithium-water.*—To 10 ccm. of distilled water add from 6 to 8 drops of a saturated watery solution of carbonate of lithium. The saturated solution may be used as a decolorizing agent in sections with over-stained nuclei.

(4) *Methylene-blue anilin oil.*—About one-half gram of methylene-blue is ground in a mortar with 10 ccm. of pure anilin oil. When the oil is saturated with the colouring matter the entire mass is poured unfiltered into a vial, where the undissolved colouring matter will settle, leaving the saturated supernatant oil clear. To a watch-glass of pure anilin oil add a few drops of the saturated methylene-blue-oil until the desired degree of colorization is obtained.

(5) Mounting, including Slides, Preservative Fluids, &c.

New Form of Clip for Balsam Mounting.*—Mr G. H. Bryan says that there are few practical microscopists who do not admit that the spring-clips which have for so many years been used in mounting objects in balsam are a failure. The usual query which has been repeatedly asked is, " Why does air run in as soon as the clip is removed?" The answer is pretty obvious, viz. that the object yields to the pressure of the clip as long as it is subject to it, but as soon as

* Journ. of Microscopy, iii. (1890) pp. 45–7 (1 fig.).

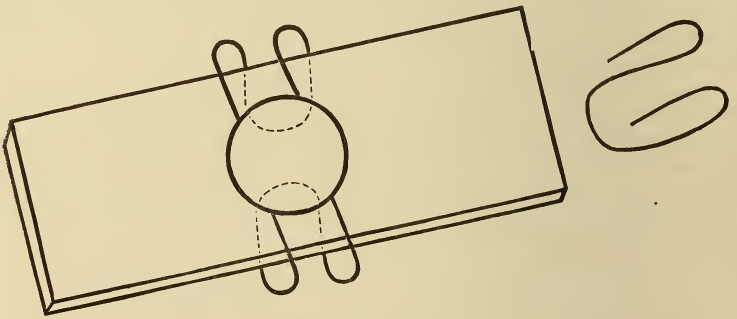
that is taken off, the elasticity of the specimen causes the latter to lift the cover up again, and what naturally happens? Why, of course the air runs in, because " nature abhors a vacuum."

Nor is this the only fault of spring-clips, for even a moderate amount of pressure is sufficient to damage many delicate specimens. Take the case of sections of stems of plants; the effect of squashing very frequently makes the cells and vessels in parts turn on one side, and where each cell should by rights be in its natural place, nothing is seen but a jumbled mass of tissue. Yet spring-clips are still frequently used in balsam mounting, the reason being that they fulfil a twofold purpose. One use of them is to produce pressure. This, as we have seen, is a bad purpose. Not but what a certain small class of specimens require flattening out, but this must be done before mounting them; it is too late to make the attempt when they are in the balsam. Their other use is to keep the cover in place while the balsam is hardening, and it is for this alone that they are usually used. They do not accomplish this end practically, for as a general rule, in applying the clip, the cover gets slightly shifted to begin with; moreover, they are almost certain to tilt the cover on one side or the other unless supports have been placed round its edges.

Nearly two years ago the idea occurred to the author that what was wanted was an arrangement that would hold the cover in its proper position by firmly gripping the edges instead of pressing down on the top of the glass. Since then he has mounted a number of slides, using these " pressureless edge clips " until the balsam has hardened, and with such success that now he " uses no other."

Fig. 29 shows one of the pressureless clips of the natural size, and how they are used for keeping the cover of a slide in its proper position.

FIG. 29.



It will be noticed that two clips are necessary, and when in use they firmly clip the slide only, their four points resting against the edges, not on the top of the cover-glass. In this way the cover is perfectly firmly held in position; it is impossible for it to slip out of place, while no pressure is applied to the object. In applying them to the slide, they are first clipped on anywhere, and then pushed up until their points touch the edges of the thin glass circle; this can generally be accom-

plished without shifting the latter perceptibly. The slide can then be handled with perfect impunity, no matter how soft the balsam may be, and a good deal of the superfluous balsam may be removed if care be taken not to displace the clips. The balsam may then, if advisable, be hardened under more or less heat; the top of a hot-water cistern is a first-rate drying-ground for the purpose. After about a fortnight in such a position, even slides mounted in ordinary balsam will generally be found sufficiently hard to be cleaned with perfect safety, but theoretically it is evident that the time taken to harden under the cover is the same as the time taken to harden in an open vessel by a layer of balsam whose thickness is one-quarter the diameter of the cover-glass. When the balsam is fully set the points of the clips will be firmly stuck down on the slides, but there is no difficulty in pulling them off; if necessary the wires might be heated, but this is not required.

Mr. Bryan now makes the clips of brass wire, the length required for each being about $2\frac{1}{2}$ in. It is advisable to make the clips of different sizes, to accommodate the different sizes of cover-glasses, and, properly, the distance between the points of the clip should be about seven-tenths of the diameter of the covers for which it is made. For use with some mounts, it is convenient to bend the points of the clip inwards, while if the object be a very thick one the points turned down will be found very useful. Where neither of these things is done, the ends may be filed off at a suitable angle, so that they hold the edges of the cover more firmly.

Quick Method of Mounting Microscopical Preparations.*—K. Schilbersky, jun., finds that numerous micro-organisms can be permanently preserved by mounting them in an aqueous fluid (water or dilute glycerin) or glycerin-jelly, by means of the following simple device.

The object is (suppose) in water, and lying about the centre of the cover-glass. Any excess of water is then to be removed with bibulous paper, so that the edges of the cover-glass are quite dry; or this may be effected by evaporation. Before the edges are dried it is advisable to pass under the cover-glass a droplet of dilute carbolic acid, to prevent the development and settlement of schizomycetes, &c. When the edges are dry, the corners of the cover-glass are to be fixed with asphalt so thick that it runs with difficulty. Along the margins and corners of the cover-glass the asphalt is to be applied by means of a brush or glass rod, in such a way that the cover-glass is not moved. When complete, the ridge may be covered with Canada balsam.

If the object is in glycerin or other fluid not a solvent of asphalt, the procedure is quite similar, but extra care must be taken with glycerin to remove all traces of it outside the edge of the cover-glass, otherwise the asphalt will not stick. This is best done with a brush or strip of blotting-paper moistened with spirit. Instead of asphalt, balsam may be used, but it is not quite so serviceable.

If the object is to be mounted in glycerin-jelly, the following modification is adopted. The object (usually obtained by maceration) is placed under a cover-glass in water or glycerin, and the latter is then absorbed by means of a pipette or blotting-paper to one-third. The

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 273-83.

cover-glass is next carefully raised, and a small piece of glycerin-jelly put in the water or glycerin which remains on the slide. The slide is then heated to melt the jelly. Air-bubbles having been pricked out, the cover-glass is replaced in its original position. It is advisable to take too little rather than too much glycerin-jelly, as the deficiency is easily made good afterwards.

Venetian Turpentine as a Mounting Medium.*—Dr. J. Vosseler recommends Venetian turpentine for mounting specimens permanently, on the ground that it possesses all the advantages of the ordinary resinous media employed for the purpose; that in some respects it is superior to them; and that it is cheaper.

Venetian turpentine is obtained from the larch, and is found to consist of a resin and an ethereal oil; consequently it is to be classed among the balsams. In colour and consistence the raw material resembles honey, but is sometimes brownish from admixture with minute fragments of bark.

To obtain a suitable solution the author merely mixes equal volumes of the crude balsam and 90 per cent. alcohol in a tall glass vessel, the top of which is protected from dust, and allows this to stand in a warm place for three or four weeks. The processes may be hastened by increasing the heat in an incubator. A clear yellowish or sometimes greenish mixture is obtained, and this is at once ready for use, as the impurities have already sunk to the bottom. These impurities may be extracted with greater rapidity by filtration. If the filtrate should be of a brownish hue, it must be thickened anew until the yellow colour returns. If the balsam be applied in a too fluid form it may become milky: should this turbidity be not too great, it will be found to disappear in a day or two; if considerable, the balsam must be dissolved out in 96 per cent. alcohol, and the specimen be remounted. The ordinary consistence of Canada balsam is that most suitable for the solution of Venice turpentine.

Prepared in the foregoing manner, Venice turpentine mixes with the reagents constantly in use in histological technique—for example, ether, alcohol 100–96 per cent., chloroform, pure carbolic acid, creosote, xylol, benzol, toluol, and the ethereal oils. Preliminary clarification of sections or pieces of tissue is quite superfluous, although when an entire animal, e. g. a small arthropod, is to be mounted, it is preferable to pass it through turpentine or creosote first. Hence, with a few exceptions, specimens are to be transferred directly from 96 per cent. spirit to this medium.

The finer details of structure are better shown in the medium than in dammar or balsam, but it is remarked that these details may disappear shortly after mounting, to reappear again on the second or third day. The medium behaves towards staining agents in the same way as other resinous substances, and is perfectly suited for specimens and sections imbedded in celloidin or paraffin.

The only inconvenience connected with the medium indicated by the author is that it is as slow to dry as dammar; but when dry it is harder and less brittle than balsam or dammar.

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 292–8.

In order to examine specimens just mounted with an immersion lens, the author mentions the following device for preventing the cover-glass from slipping. A couple of needles, made hot, are laid along two sides of the cover-glass. This causes the resin to thicken from evaporation of the solvent. Of course, all the four sides might be banked up in this way, and the device is quite suitable for similar conditions of balsam or dammar.

Fixatives for Diatom Preparations.*—Herr E. Debes, after alluding to the isobutyl-alcoholic solution of shellac introduced by Dr. Witt, and which, though eminently suitable for a mounting medium, is equally difficult to make, proceeds to discuss two kinds of media convenient for mounting diatoms. These are resinous and gelatinous preparations. The resins are certain copals, and these are divisible into three classes according to their solvency in turpentine. To the first class, which is quite insoluble, belongs Zanzibar copal; to the second, Manila or soft copal—this is only imperfectly soluble; the third class includes those resins which, being quite soluble, are omitted.

The Zanzibar, or insoluble copal is made into solution with isobutyl-alcohol, after having been previously treated with turpentine to dissolve out any resinous matter that may be present. The filtrate is then dissolved in isobutyl-alcohol and again filtered. The solution is quite colourless and clear, and is at once ready for use.

The diatoms are fixed by placing on a 3-mm. cover-glass a small drop of the liquid, which spreads itself out all over the cover. The cover-glass is then put on a metal plate, heated by a spirit-lamp, and when the proper degree is arrived at, the diatoms are arranged. This degree is estimated by placing close to the cover-glass a small fragment of resin on a bit of cover-glass, and when the fragment is quite dissolved the correct degree of heat is indicated and the source of heat removed.

Another way of estimating the proper amount of heat is to place a small strip of white writing-paper on the hot plate, and when this turns colour (white to yellow or brown), the source of heat is removed. After having been heated, both these resins (Manila and Zanzibar) become less soluble, an inconvenience which, as may be understood, may cause disasters if not properly anticipated.

The gelatinous media are made from gelatin or isinglass. Two grm. of pure white gelatin are dissolved in 70 ccm. of glacial acetic acid (or 3 grm. of isinglass in 75 ccm.), the mixture being placed in a well-stoppered bottle. By frequent shaking, the solution is effected in three or four days. The process may be hastened by heating in a water-bath. If isinglass be used the solution must be filtered to get rid of fat and fibres. Five grm. of the solution are then diluted with a mixture of 3 grm. of ethyl-alcohol and 1·5 grm. isobutyl-alcohol. The mixture is made by squirting in small quantities of the latter through a pipette, and constantly shaking. If a cloudy or opalescent precipitate be formed, a little more acetic acid must be added.

The solution must be put in a well-stoppered bottle and kept in a cool dark place. The fluid, which keeps well, is put on the cover-glass &c., with a pipette; a small drop runs out peripherally to form a thin

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 283–92.

even layer. The diatoms are laid on dry, and fixed in position by merely breathing ever so lightly upon the cover-glass.

Sterilization of Water by the Chamberland Filter.*—M. L. Dor finds from several experiments that Chamberland's filter may be confidently relied on for removing bacteria, for by means of it the author has succeeded in rendering the water perfectly free of germs.

Microchemical Test for Alkaloids and Proteids.†—M. L. Errera finds, as the result of numerous and prolonged experiments between alkaloids and proteids, that alcohol acidulated with tartaric acid fulfils all the conditions required for a good test between these two classes of highly organized bodies; for the alkaloids are removed by means of the tartaric acid, and the proteids remain behind. Hence little difficulty will be experienced in distinguishing the one class of compound from the other. The experiments were made upon colchicine, pepton, mucor, ciguë, and lupin.

"Air-gas" for Bacteriological Work.‡—Dr. O. Katz, who had to work on Rodd Island, N. S. Wales, where the ordinary appliances of civilization were not available, made use of the "Alpha patent gas-making machine." This apparatus produces gas in the shape of a mixture of atmospheric air and the vapour of petroleum spirit (gasoline), the mixture being called air-gas. By means of weights atmospheric air is pumped through a drum into a chamber, where it is impregnated with the vapour of the volatile fluid. The mixture then passes into a gasometer, from which the burners are supplied automatically. The author used a 40-light machine capable of yielding 200 feet of gas an hour.

The author considers that air-gas makes an efficient substitute for coal-gas for ordinary lighting purposes, and he also used it with success for heating thermostats, and also for other bacteriological purposes.

(6) Miscellaneous.

Changes in the Firm of Zeiss.§—The firm of C. Zeiss, in Jena, has advertised by circulars a change in their management. Dr. Ernst Abbe, who has hitherto acted as general manager of the firm, was, on November 29th, 1889, admitted into the firm as partner with Dr. R. Zeiss, and has now undertaken the sole management of the company so formed. At the same time power of procuration of the firm has been given to Dr. Otto Schott, of Jena; and Dr. Siegfried Czapski, of Jena, has also been authorized to represent the firm in all business matters.

Correction, by Dr. H. van Heurck.—Dr. H. van Heurck, Director of the Jardin Botanique, Antwerp, requests us "to correct an error, or rather an omission," which occurred in his note on *Pleurosigma angulatum*.‖

He wrote:—"The last photograph, No. 6, shows that the valve of *Pleurosigma* is formed of two layers." In writing this phrase he states: "I had in view the upper membrane and the intermediate layer, which are

* Lyon Médical, 1889, No. 23. Cf. Centralbl. f. Bakteriol., vii. (1890) p. 75.
† Annales Soc. Belge de Microscopie (Mémoires), xiii. (1889) pp. 72–121.
‡ Proc. Soc. Linn. N.S.W., iv. (1889) pp. 328–30.
§ Zeitschr. f. Instrumentenk., x. (1890) p. 37.
‖ *Ante*, p. 104.

seen in this photograph, the lower membrane which is beneath not being visible. My clerk omitted the two words "at least," thus completely altering the sense and placing me in contradiction both with the statements in my Synopsis, published in 1885, and with the note on the 'Structure of Diatom Valves' which I recently sent to the Royal Microscopical Society, in which I everywhere admit the existence of three layers."

New Photograph of P. angulatum, by Dr. H. van Heurck.—At the March meeting of the Society a photograph, by Dr. H. van Heurck, was exhibited of *P. angulatum*, produced with Zeiss's apochromatic objective of 1·6 N.A., in further elucidation of Dr. van Heurck's views on the structure of diatom valves.

The note accompanying the photograph was as follows:—

"I have the honour to submit to the Royal Microscopical Society a photograph of *P. angulatum*, made with the objective of 1·6 N.A., using strictly axial illumination. The fracture of the upper edge shows clearly that the "beads" are holes in the intermediate layer, and that the form of these holes (beads) is hexagonal, as maintained by Mr. Smith and myself. The form of the small bar on the extreme top, which is the part of the negative focused, shows that the "beads" cannot be round."

The Formation of Images in the Pleurosigma formosum.—Mr. E. M. Nelson communicated the following note to the Society at the meeting of the 19th March:—"It was stated at the January meeting of the Royal Microscopical Society that it was impossible to produce images in the markings on a *P. formosum*. Some years ago it was said that images formed by the primary structure of coarse diatoms, such as *Triceratium* and *Coscinodiscus*, proved that the markings were lenticular. With this opinion I did not agree, and was led to investigate the subject. I not only confirmed the experiment with regard to the coarse diatoms, but eventually succeeded in producing images in the *P. formosum*. I also produced images in minute holes punctured in a piece of tinfoil. This latter experiment shows that the production of images in diatom markings does not prove that they are lenticular. I have now made a photomicrograph of a *P. formosum* with images formed in the markings × 2000. The images might have been made more distinct had more time been expended on the photomicrograph."

PROCEEDINGS OF THE SOCIETY.

Annual Meeting held 12th February, 1890, at King's College, Strand, W.C., the President (Dr. C. T. Hudson, F.R.S.) in the Chair.

The Minutes of the meeting of 8th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Kühne, H., Practical Guide to the Demonstration of Bacteria in Animal Tissues. Translated by F. D. Harris, M.D. viii. and 53 pp. and 7 figs. (8vo, London, 1890)	*Dr. Harris.*
Tryon, H., Report on Insects and Fungus Pests. Pt. I., ix. and 238 pp. and 4 pls. (8vo, Brisbane, 1889)	*Mr. H. Tryon.*

Mr. Crisp having read the notice given at the January meeting, as to the alterations it was proposed to make in the Bye-Laws, it was moved by Mr. Glaisher, seconded by Canon Carr, and resolved :—

(1) That Article 36 of the Bye-Laws of the Society be suspended for the purpose of allowing Dr. C. T. Hudson to be eligible for election to the office of President for the ensuing year, notwithstanding that he has already been elected to such office for two years in succession.

(2) That Articles 37, 61, 74, and 77 of the Bye-Laws be altered so as to read as follows :—

37. The Council at their meeting in November shall prepare a list of Fellows to be recommended to the Society for election at the ensuing annual meeting, which list shall be read at the general meeting in December.

61. Two Ordinary Fellows, one a member and the other not a member of the Council, shall be appointed at the general meeting in December, to audit the Treasurer's account for the past year. They shall have the power of calling for all necessary books, papers, vouchers, and information.

74. The ordinary meetings of the Society shall be held at 8 o'clock p.m., on the third Wednesday in each month, from October to December, and February to June, inclusive.

77. The annual meeting shall be held at 8 o'clock p.m. on the third Wednesday in January.

Mr. Crisp read the following list of Fellows nominated by the Council as Officers and Council of the Society for the ensuing year :—

President—Charles T. Hudson, Esq., M.A., LL.D. (Cantab.), F.R.S.

Vice-Presidents—*Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.;

* Have not held during the preceding year the office for which they are nominated.

James Glaisher, Esq., F.R.S., F.R.A.S.; Prof. Urban Pritchard, M.D.; *Charles Tyler, Esq., F.L.S.

Treasurer—*Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.

Secretaries—Prof. F. Jeffrey Bell, M.A.; *John Mayall, Esq., Jun., F.Z.S.

Twelve other Members of Council—Alfred W. Bennett, Esq., M.A., B.Sc., F.L.S.; Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; *Rev. W. H. Dallinger, LL.D., F.R.S.; Prof. J. William Groves, F.L.S.; *Richard G. Hebb, Esq., M.D.; George C. Karop, Esq., M.R.C.S.; Albert D. Michael, Esq., F.L.S.; Thomas H. Powell, Esq.; *Walter W. Reeves, Esq.; *Prof. Charles Stewart, F.L.S.; William Thomas Suffolk, Esq.; Frederic H. Ward, Esq., M.R.C.S.

Canon Carr and Mr. Vezey were appointed Scrutineers by the President, and the ballot was proceeded with.

The Treasurer, Dr. Lionel S. Beale, F.R.S., then read the annual statement of accounts from the duly audited balance sheet (see p. 264).

Dr. Beale then formally resigned the office of Treasurer of the Society, at the same time congratulating the Fellows upon the fact that he was about to be succeeded by one who would no doubt make a more useful Treasurer than he himself had been able to be. Although the Treasurer was not dead, he might heartily say, "Long live the Treasurer."

The President felt sure that all present would join heartily in according a vote of thanks to Dr. Beale for his services, not only during the past year, but throughout the long time during which he had undertaken the duties of Treasurer of the Society. It was a great pleasure, not only to have had him as their Treasurer, but also to know that they were still to retain him amongst them as one of their Vice-Presidents.

Mr. Crisp, in seconding the motion, said that it was a matter of surprise to him at the time, that Dr. Beale accepted the office of Treasurer when asked to do so, seeing the nature and number of his professional engagements; but he not only cheerfully undertook the office, but carried out the duties with punctuality and efficiency. It might also be mentioned that he had resigned his office in a very genial manner, under circumstances, which perhaps, he might be permitted to mention. When he himself was obliged to give up the office of Secretary and Editor of the Journal, it was desired by the Council that he should remain in some official connection with the Society, but in what way they could not very clearly settle. Dr. Beale, happening to come in at the moment, grasped the situation and resigned the Treasurership at once, to meet the difficulty, so that he felt they owed him a double debt of gratitude on the occasion.

The motion, having been put by the President, was carried unanimously.

Dr. Beale expressed his thanks to the meeting for the very cordial way in which this vote of thanks had been passed, though he felt that

* Have not held during the preceding year the office for which they are nominated.

THE TREASURER'S ACCOUNT FOR 1889.

Dr.

1889.	£	s.	d.
To Balance brought from 31st December, 1888	116	0	1
,, Interest on Investments	84	2	4
,, Admission Fees	77	14	0
,, Annual Subscriptions	810	14	6
,, Compositions	63	0	0
,, Reprints sold	1	10	0
,, Catalogues sold	2	5	0
,, Screw tools sold	1	5	0
	£1156	10	11

Cr.

1889.	£	s.	d.
By Rent, Gas, and Attendance	95	11	9
,, Salaries, Reporting, and Commission	190	15	6
,, Books and Binding	95	5	6
,, Expenses of Journal (less receipts)	450	1	7
,, Postage of Journal	78	6	10
,, Reprints from Journal	8	7	6
,, Stationery and Miscellaneous Printing (including Library Catalogue and Charter)	63	19	9
,, Coffee at Evening Meetings	18	11	0
,, Fire Insurance	3	0	0
,, Petty Cash	37	2	0
,, Balance remaining 31st December, 1889	114	19	6
	£1156	10	11

LIONEL S. BEALE, *Treasurer.*

Investments, 31*st December*, 1889.

1200*l.* Freehold Mortgages. 875*l.* 19*s.* 8*d.* India Three per Cents. (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 16th January, 1890.

W. T. SUFFOLK,
J. D. HARDY, } *Auditors.*

whilst he had always endeavoured to attend to the duties properly, he had not done more than any other Fellow of the Society would have done under the circumstances.

Prof. Bell then read the Report of the Council for the past year as follows:—

REPORT OF THE COUNCIL.

The Council are glad to be able to report the continued prosperity of the Society during the year 1889.

Fellows.—39 new Fellows were elected, being approximately the average of the last ten years, whilst 21 died or resigned. One Honorary Fellow, Rev. M. J. Berkeley, died, whose place was supplied by the election of Mr. John Ralfs, the author of 'British Desmidieæ.'

The list of Fellows now contains 659 Ordinary Fellows, 50 Honorary, and 88 Ex-officio, or a total of 797.

Finances.—As many of the Fellows who died or resigned were either compounders or subscribers under the old scale of 1 guinea, the annual revenue has been substantially increased, the increase amounting to 39*l.* 18*s.* 6*d.*

The capital funds of the Society remain at the amount reported last year, namely, 1200*l.* on mortgage, and 875*l.* 19*s.* 8*d.* invested in India 3 per Cents.

Rooms.—As previously reported, the Council have succeeded in obtaining rooms at 20, Hanover Square, under a lease from the Royal Medical and Chirurgical Society.

The accommodation consists of two rooms on the second floor, which will be reserved exclusively for the use of the Society, with the right of meeting in a large commodious meeting room on the ground floor. The Society has a lease for 21 years, at a rent of 130*l.* a year, which includes rates and taxes and also electric lighting.

The extra expense caused by this lease will be met by the increase in revenue above referred to.

Journal.—It was with much regret that the Council received the announcement of the retirement of Mr. Crisp from the Editorship of the Journal and Secretaryship of the Society, but as they found that it was quite impossible for him to reconsider his determination, they had no alternative but to acquiesce in it. The Council cannot refrain, however, from placing on record their sense of the deep obligation which the Society is under to Mr. Crisp for his labours of the last twelve years, both as Secretary of the Society and as Editor of the Journal. The Council are glad that Mr. Crisp has seen his way to accept the Treasurership, so that his official connection with the Society will remain unbroken.

Dr. Beale felt sure the Fellows of the Society would consider this a very satisfactory report; he had therefore much pleasure in moving that it be received and adopted, and that it be printed and circulated in the usual way.

Mr. Vezey having seconded the motion, it was put to the meeting and carried unanimously.

The President announced that the Scrutineers had handed in their report of the result of the ballot, showing that the whole of those whose names were printed in the list had been elected.

The President said he had in the first place to thank them for the honour they had done him by electing him to a third year of office, a very graceful act on their part when it was remembered how imperfectly, owing to his absence from many of the meetings, he had been able to discharge his duties. It had been a great pleasure to him to be in his place whenever his health had permitted, and it had been a still greater pleasure to observe how greatly the Society had flourished, not on account of, but during his Presidency, and he could only add to this the hope that its prosperity would both increase and be long continued.

"And now, gentlemen, I propose to deviate from the usual custom of the chair, and, acting as I believe you, under the circumstances, would wish me to do, not only to propose, as your spokesman, the usual vote of thanks to your Secretaries for the admirable way in which the affairs of your Society have been conducted during the last year, but to express to your senior Secretary, Mr. Crisp, our gratitude for his long and unwearied labours, and our deep regret that he has found it imperatively necessary to resign his office.

Mr. Crisp has now discharged the arduous duties of Secretary and Editor of our Journal for twelve years; and during that time the Society has doubled its numbers and has greatly improved its position and influence; results which I feel sure you will consider to be due, in no slight degree, to the energy, sound advice, admirable tact, and unfailing good temper of our senior Secretary. Our Journal, too, as the 'Athenæum' has justly said, has, during his editing, 'been converted into one of the most useful aids to research which can be put into the hands of working biologists. It has averaged a thousand pages in each volume, and its circulation is understood to be more than a thousand copies.' Mr. Crisp's editing has been the reverse of nominal. Of course he has had the assistance of very able and willing colleagues, but when I mention that, till quite lately, he has selected nearly all the papers to be noted; that he has read all the proofs, and often made excellent suggestions on them; and that he has himself largely written the part of 'Microscopy,' I have said enough to show how much we lose in parting, not only with our Secretary, but also with our Editor.

But this is by no means all. It is to him that we are indebted for the introduction of Prof. Abbe's theories to the notice of English microscopists and opticians, and for a lucid explanation and vigorous defence of them. Strictly speaking, Dr. Henry Fripp, of Clifton, then President of our Bristol Microscopical Society, was the first to translate Prof. Abbe's original paper; but his translation, which was published in the 'Proceedings' of the Bristol Naturalists' Society, attracted little notice, till Mr. Crisp republished it, with others following it, in your 'Proceedings.'

You, of course, well remember the storm that raged round immersion lenses and angles of aperture, &c., and how your Secretary never wearied in exploding fallacy after fallacy, as one antagonist after another rose up to maintain the old ideas. His victory, indeed, has been so complete,

that it runs the risk even of being forgotten from want of opposition. But the results of his victory remain; and it is not too much to say that to it is, in a very large measure, due the great improvement in our lenses which has taken place within the last few years, culminating in those beautiful apochromatic objectives which give promise of making many things familiar to us about which, hitherto, we have only feebly guessed.

Nor can our thanks stop here: for I think that on an occasion like this, I may be permitted to allude to the material assistance which Mr. Crisp has generously given to the Society, in the heavy expenses of the Journal, and to tender him our hearty thanks for that assistance. It is enough, indeed, merely to mention the fact, which speaks volumes for the interest that Mr. Crisp takes both in microscopical science and in the Royal Microscopical Society itself.

We are, too, all greatly indebted to our senior Secretary for the opportunities that he has given us of studying his splendid collection of Microscopes, from the earliest to the most modern times, and of rare books which treat of their use and structure: and I am sure that when he next surveys the cabinets which hold his treasures he may say, as his eye rests on the twelve goodly volumes of our Journal, 'Monumentum exegi ære perennius.'

It is, morever, a source of no little satisfaction to us all that Mr. Crisp has accepted the office of Treasurer, so that we shall still benefit by his able advice and kindly presence; and in conclusion I can only assure him (speaking as I do for the whole Society), that in retiring from the Secretaryship he takes with him our warmest thanks, and our heartiest good wishes for his continued health, happiness, and prosperity."

He felt that it was unnecessary for him to call upon any one to move and second the adoption of that which he had read, and would therefore put it at once to them. The resolution was carried by acclamation.

Mr. Crisp said if he were now upon the point of altogether retiring from his official connection with the Society, he should perhaps take a more formal farewell than it was his intention to do under the circumstances, inasmuch as he was only shifting his position from one office to another, and intended to continue to attend all the meetings, just the same as he had done, with one exception, during the last twelve years. The President had drawn rather too rosy a picture of his association with them during that period; that, however, could be corrected before it appeared in print. But whilst he thanked them sincerely for this expression of goodwill, he could hardly regard what he had done as altogether arising from disinterested motives, because he had taken great pleasure in the work connected with the Society, which had been to him a matter both of relaxation and amusement, and any expenditure incurred had been more than repaid by the advantages he had derived from it.

The Rev. T. S. King said he should like—as one of the country Fellows of the Society—to say how greatly those who, like himself, lived at a distance from London, felt their indebtedness to Mr. Crisp for the way in which he had supplied them with the remarkable amount of information to be found in the Journal. He ventured to hope that the

President would exercise the despotic power which belonged to him in preventing the paper which he had just read from being in any way mutilated in passing through the press.

The President then read his Annual Address (see p. 129), concluding with the exhibition of a number of transparencies, which he explained seriatim.

Prof. Bell was sure they would agree with him that a vote of thanks should be moved for the very instructive and entertaining address to which they had just listened, leaving them, as it did, so much to think about, and presenting to them in an original manner a view which was gaining considerable credit with the naturalists of to-day. The matter to which the President had directed their attention had passed through several stages, and the ultimate result was that the natural objects of their studies had become too much obscured, and the difference between the field naturalist and the cabinet naturalist far too great. The study of the science of natural history began with Linnæus, who gave them a system of nomenclature and method of classification, and there was no doubt that the method which he adopted was so complete and perfect that it had been found practically impossible to improve upon it. Then came the age of Cuvier and Richard Owen, in which people got so interested in the bones and teeth that they seemed quite to forget the true study of the forms from which those bones or those teeth were derived. After this came the age of Von Baer and his followers, people who knew so much about eggs, but so little about what the creature was from which the egg came—people who got an egg, but what it was to produce or whether it came from a reptile or a guinea-pig were matters on which they seemed unable to be certain. After these came Darwin and that so-called Darwinism which had been used as a means for weaving phylogenies by Germans and others; and now they seemed to be reaching a period when there was arising a truer Darwinism, and there was still a class of naturalists who were able to follow its leadings. What Darwin did for this portion of his followers, what the President was himself doing in the lines which he had taken, what was being done at Naples and at our own marine zoological station, would, he believed, give a great impetus in a true direction to these studies, and would put them in touch again with those who were so fond of nature that they wanted to know the truth about her. He believed, therefore, that a time had come when zoology could no longer be defined as interesting to those who were interested in the study of words. Books were not without their uses, and in connection with the subject brought before them it was undoubtedly as necessary to have a book as to have the natural forms. The President and Mr. Gosse had given them one sort of book; might they not hope that the address to which they had been listening indicated that the President would also provide them with the other?

Mr. Glaisher said he had much pleasure indeed in seconding the vote of thanks which had been proposed by Prof. Bell to be given to the President for his very admirable address of that evening. When the latter gave his first address to their Society he thought he passed the highest compliment upon their transactions by such a contribution to them, and now, at the end of his second year of office, he had not only

given them an address, but had shown them some of the results of his researches by means of the very beautiful illustrations which he had placed before them. An address such as that could not fail to give a great impetus to others to go and do as he had done. He felt that their warmest thanks were due to the President for this address, which he presumed would be printed and circulated amongst the Fellows in the usual way.

The motion having been put to the meeting, was unanimously carried.

The President said at that late hour of the evening he would not do more than thank them very heartily for the vote of thanks, and for the very kind way in which they had taken not only his Address, but his services for the year, notwithstanding the imperfections from occasional absences from the meetings of the Society from causes beyond his control.

Mr. Crisp said they must not separate on that occasion without passing a vote of thanks to their Auditors—Mr. Suffolk and Mr. Hardy—for their services. He had much pleasure in proposing it.

Mr. Glaisher seconded the motion.

The motion having been put to the meeting by the President, was carried unanimously.

Mr. Crisp reminded the Fellows that they had now held their last meeting in that room, and that in future they would meet in their new premises, No. 20, Hanover Square, on the third Wednesday in the month, so that their next meeting would be held on March 19th.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Thomas D. Aldous, George M. Elwood, H. A. Francis, and William Odricks.

MEETING OF 19TH MARCH, 1890, AT 20, HANOVER SQUARE, W., PROFESSOR U. PRITCHARD (VICE-PRESIDENT), IN THE CHAIR.

The Minutes of the meeting of 12th February last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Zeiss's New Apochromatic Objective of 1·6 N.A., condenser, slide of diatom preparations, 12 flint glass slips, and 20 cover-glasses	*Prof. E. Abbe.*
Photograph of *P. angulatum* produced with Zeiss's Apochromatic Objective of 1·6 N.A., and axial illumination	*Dr. H. Van Heurck.*

A letter from the President was read by Prof. Bell, regretting his inability to be present at the meeting, in consequence of a fall, from the effects of which he was suffering severely at the time of writing.

The Chairman was sure that the Fellows of the Society would agree with him that it was a very great loss to them not to have the President

with them on the occasion of their first meeting in their new rooms. He hoped, however, that his recovery from the effects of the accident would soon take place, and that they would before long see him amongst them again.

Mr. J. Mayall, junr., said that before entering upon the business of the evening he must thank the Fellows of the Society for the honour which they had done him in electing him to the office of Secretary. He desired to say that during his tenure of the Secretaryship it would be his endeavour and chief aim to promote the welfare of the Society as far as he was able, and to give every one who was interested in the study of microscopy the fairest possible play at the meetings. Because he held certain views upon optical questions, it must not be thought that he was unwilling to hear those who differed from him on those subjects; on the contrary, he desired that, so far as the interests of the Society permitted, every one should be at liberty to state his opinions in the freest and fairest way.

Mr. Mayall said that the Society had since their last meeting received a donation of a specially interesting character, from Prof. E. Abbe, of Jena, namely, one of Zeiss's new apochromatic 1/10th objectives, of 1·6 N.A. It would be remembered that the new objectives had recently formed the subject of several communications to the Society. When first he heard from Dr. Czapski, of the firm of Zeiss, of an intention to send one of the objectives to the Society, he was not quite certain whether it was to be sent as a donation or for inspection only. Upon further inquiry, however, he found that it was sent to them as a donation, as would be seen from the letter, dated Jena, 17th inst., just received from Prof. Abbe, as follows:—

> "A few months ago our co-operator, Dr. Czapski, of this town, communicated with the Royal Microscopical Society on the subject of a new objective of increased aperture, which had been constructed by us last year. The Editors of the Journal of the Society published this communication in the February number of the Journal, in the Transactions of the Society, and they also gave a full account of observations made with the lens.
>
> The aim which was held in view in the construction of the objective—viz. to increase the aperture of the microscope to the maximum degree obtainable with the means at present available in practical optics—unavoidably involves such restrictions in the use of the objective as to render its application very limited. It is, therefore, not to be expected that this objective will be at all extensively employed by microscopists, and, in fact, only a small number of these lenses have as yet been constructed.
>
> It was, however, our opinion that it would be of some interest to the Fellows of the Royal Microscopical Society to test the result of this, our experiment, by ocular inspection. We accordingly constructed one of these lenses specially for the Royal Microscopical Society, and now forward it by our agent, Mr. C. Baker, of London, requesting the Society's acceptance of it as a token of our estimation of the valuable services rendered by the Society towards the advancement of microscopical optics."

Mr. Mayall said the new objective would naturally be regarded by the Society with extreme interest. In order that its merits might be tested, the Council had recommended that Dr. Dallinger, Mr. Nelson, and himself, should form a committee for the purpose of examining it, and reporting the result at their next meeting. Prof. Abbe had forwarded with the objective a condenser, of 1·6 N.A., and a flint-glass slide, containing mixed diatoms mounted by Dr. Van Heurck, of Antwerp. It was, of course, understood that in order to exhibit the full power of the increased aperture, it was necessary to employ a condenser of corresponding aperture, and the objects to be viewed must be mounted on slips, with covers, and mounting and immersion fluids of corresponding high refractive power.

Mr. C. L. Curties said that Prof. Abbe had also sent for the Society's acceptance a supply of flint-glass slips and cover-glasses for use in mounting objects for examination with the new objective.

The Chairman was sure that the thanks of the Society would be given to Prof. Abbe for his valuable and interesting donation, and that the Society would be very much interested in hearing the report of the gentlemen who had undertaken to examine it.

Mr. Mayall called attention to two Microscopes exhibited by Mr. Crisp. One of these was an example of the highest grade of construction made by M. Nachet; a special novelty about it was that the stage was fitted with two small mirrors, one concave and one plane, which were placed right and left of the stage, so that an observer looking down the body-tube with one eye could see in the plane mirror with the other eye the image of the profile of the objective, and could thus see when the objective was approaching dangerously close to the cover-glass, an advantage which he was himself hardly able to appreciate. He thought appliances of that kind interfered with the freedom of manipulation. The general construction should be compared with that of other opticians in France, and then it would probably be found to rank high, for centering movements were applied to the substage, which had also a fine-adjustment. There seemed to have been an oversight in the fitting of the rackwork of the coarse-adjustment, because when run down low with the pinion, the body-tube was apt to slip away from the pinion and crush down upon the stage.

Mr. Crisp said this defect had been noticed by himself, and he had also found, in handling the stand with average care, the body-tube rack ran so unusually free that the lower part of the instrument had narrowly escaped dropping on the floor in the removal from one table to another.

Mr. Mayall said that the other Microscope exhibited by Mr. Crisp was constructed by M. Pellin, of Paris, successor to the late Jules Duboscq, for the purpose of examining and photographing adulterations in food, which was one of the official duties at the Paris Municipal Laboratory. It stood upon a wide tripod provided with levelling screws, which were probably of use in examining fluids. The photographic accessories were of substantial construction, consisting of a brass shaped tube, the smaller end fitting as a socket over a cylindrical chamber encircling the eye-piece, and the upper end receiving the sensitive-plate holder at about twenty inches from the objective.

Mr. Crisp pointed out that the cylindrical chamber round the eyepiece was a very awkward arrangement for the observer, not at all calculated to facilitate observations.

Prof. Bell announced that the Council had nominated for election as an Honorary Fellow of the Society, Prof. F. Leydig, of Bonn, whose name would be submitted for election at the ensuing meeting.

Prof. Bell also stated that, in connection with a movement which had been set on foot for the purpose of presenting a memorial to Prof. Pasteur, one of the Honorary Fellows of the Society, a letter had been received from Mrs. Priestley, inclosed with which was a page of the memorial upon which the signatures of Fellows of the Society were to be placed. The Council had signed it as requested, and there was about half the page left for the signatures of any other Fellows who might like to record their names also, whilst it was intimated that another page might be procured if found necessary.

Mr. Rousselet said that he exhibited a number of Rotifers, chiefly for the purpose of showing their abundance at the present season of the year.

Prof. Bell read a letter received from Colonel O'Hara with reference to a specimen exhibited in the room, which was supposed to be some kind of Entozoon passed in urine.

Prof. Stewart said he had looked at this object; it was not very transparent, and therefore not easy to determine, but it looked like a Trematode worm of some sort. These things were well known as occurring in the bladders of frogs and Amphibia, but so far as known to him they had not been found before in human urine.

Prof. Bell said the letter did not state that the object was found in human urine.

Prof. Bennett thought that to be heard well in that room it would be necessary for speakers to raise their voices to a higher tone than was usually adopted. There seemed to be a good deal of resonance somewhere, and much of what had been said had been very imperfectly audible from where he was sitting.

Prof. Stewart thought that the tone of the speaker was not of so much consequence as the clearness and slowness with which he spoke, as the difficulty was due rather to the nature of the room. Probably if some kind of curtain or banner were hung up so as to prevent the reflection of sound from so many surfaces it would greatly modify the defect which had been noticed.

Prof. Bell said it would be remembered that at their meeting in January last a paper was to have been read by Mr. Michael "On the Variations of the Female Reproductive Organs, especially the Vestibule, in different species of Uropoda," but that, owing to a want of time on that occasion, the subject was postponed until March. Since then he regretted to say that Mr. Michael had been seriously ill, and was con-

sequently unable to read his paper as they had hoped. The paper had been sent to the printer, but it had been returned to him without the proof of the plate by which it was to be illustrated, and not having therefore the opportunity of comparing the figures with the descriptions given in the text, he was unable to give a sufficiently clear explanation of the very minute details entered into by the author. He gave, however, such a *résumé* as was possible under the circumstances.

Prof. Stewart, who had seen some of Mr. Michael's specimens, pointed out the chief features illustrated by the diagrams.

The Chairman expressed the thanks of the Society to Mr. Michael for his communication, and the regret which he was sure they felt at his absence.

Mr. C. H. Wright gave a description of a new British hymeno-lichen, and exhibited specimens lent for the occasion from the herbarium at Kew. His observations led him to the conclusion that the species was *Cyconema interruptum*, which he believed to be a synonym of *Rhizonema interruptum*, and that in future descriptions the last-mentioned term must be omitted.

Prof. Bennett regretted that he had not been able clearly to hear the observations of Mr. Wright, but if he rightly understood the purport of his remarks, it was that this form must in future be referred to the genus *Cyconema*, which was an exceedingly polymorphic family. He thought it was a fact of great interest to have found this form in this country.

Mr. E. M. Nelson read a short note with reference to a statement alleged to have been made at one of the meetings of the Society, to the effect that it was impossible to produce images of external objects from the markings of *P. formosum*, and he said it had been contended that the production of such images did not prove that the openings were lenticular. Images could be seen so long as they were within the resolving power of the lenses employed.

Mr. Crisp said he was present at the meeting referred to by Mr. Nelson, but did not hear any one say that images could not be produced in *P. formosum*, because it was well known that in *P. formosum* they could, Dr. Matthews having shown them. The whole point was that they could not do it after they reached a certain limit, and *P. angulatum* being beyond that point, they could not see them there.

Mr. Mayall said that *P. formosum* might be within the limit, but *P. angulatum* was never within it so far as he knew. He remembered that the question was submitted some years ago to Prof. Abbe, and he replied that *P. formosum* was, generally speaking, within the limit.

Mr. T. F. Smith would have thought that if they had a cross shown by *P. formosum*, and they also had one produced by *P. angulatum*, it would point to their being of the same structure.

Mr. Mayall would be glad to have the matter of fact first demonstrated by the production of photographs of the image of a cross produced by the structure of *P. angulatum*; the rationale of the phenomenon might then be a subject for useful discussion at the Society.

Mr. Crisp suggested a prize to be offered in connection with this

matter. He did not say that a cross was produced, but "*what looked like a cross*"—not being an image, but an effect caused by the intersection of points.

Mr. Nelson thought Mr. Crisp was mistaken in his description of what was done by Dr. Matthews, for although he showed crosses in the case of some of the coarse diatoms, he did not produce them with *P. formosum*, but he did produce a bar which was the image of a pin. It should be remembered that at that time it was more difficult to show these things than with their present apparatus. It was always exceedingly difficult to show the image in the markings, because by the time they reached the image the markings were out of focus, but they could sometimes show a very much out-of-focus hole with some sort of image got out of it. He remembered that at a microscopical *soirée* some one showed the seconds hand of a watch in the eye of a beetle, but it was found impossible at the same time to show the hexagonal holes. He thought they would also be unable to show it in photography, because the holes would have all run together by the time the crosses were focused. Possibly the new lens of 1·6 N.A. might help them.

A note was read from Dr. van Heurck correcting an error in his recent communication to the Society relating to the structure of diatoms. An enlarged photograph of a photomicrograph of *P. angulatum* by Dr. van Heurck was also handed round for inspection.

Mr. Crisp thought that for *P. angulatum* it was a remarkable photograph.

Mr. Mayall read a translation of an article * by Prof. E. Abbe in the 'Zeitschrift für Instrumentenkunde,' of January, relating to the use of fluorite for optical purposes, in which it appeared that the special qualities of the new apochromatic objectives were due to the employment of fluorite lenses in their construction. This mineral had lower refractive and dispersive indices than any optical glass hitherto produced, and its introduction as a new element in the construction of Microscope objectives enabled the optician to reduce the spherical and chromatic aberrations much below the point previously reached in achromatic combinations of the usual construction. Following upon the publication of Prof. Abbe's note, Mr. Mayall said, the essential secret of the apochromatic formula appeared to be disclosed, and he hoped the English opticians would soon recover the ground lost through their neglect to discover the fact of the employment of fluorite in Zeiss's new lenses. The Society were of course most desirous of promoting optical improvements, and as it appeared that fluorite in crystals of the requisite size and clearness seemed hardly obtainable in Europe, it was important that other sources should be found. He trusted that those Fellows who had correspondents abroad, where there was any probability of obtaining such fluorite, would not fail to engage them to inquire as to the possibility of discovering a supply of the mineral, and would bring the matter before the Society, should their efforts prove successful. Applications were already on the way to the Brazils, Chili, and Peru, thanks to the

* To be published in the next number of the Journal.

co-operation of Mr. F. Justen, a candidate nominated for the Fellowship of the Society that evening.

Prof. Bell said he had asked the opinion of Mr. Davis (of the British Museum) upon this subject, and he told him that it was almost impossible to get it clear anywhere.

Mr. Crisp thought that if it was a fact that this crystal was used as suggested, it seemed as if something else would do as well, because, when Mr. Powell produced his lens, it was said to be nearly, if not quite, equal to those produced by Zeiss.

Mr. Powell said that their lenses were not made of it, but he felt equally sure that the first apochromatic lenses sent to England by Zeiss were not altogether made of Schott's glass as was supposed.

Mr. Mayall said the matter referred to by Mr. Crisp needed explanation. There was no doubt that when Mr. Powell brought out what he termed his "apochromatic" objective, and it was compared with the Zeiss apochromatic, the opinions of experts were balanced as to their comparative merits. The estimations were then made by the eye only —by the images seen in the Microscope. Since then, however, it had been found that the production of photomicrographs by the rival objectives was a still more searching test—a test that could not be neglected when once fairly tried. Judged, then, by the photomicrographic test, the Zeiss apochromatic objectives proved superior, although when compared by the eye only the rival lenses showed but minute differences—differences in the earliest trials that were slightly in favour of Mr. Powell's work. With reference to Mr. Powell's remarks as to the various kinds of glass employed in the apochromatic constructions by Zeiss, he (Mr. Mayall) thought Mr. Powell's criticism was probably accurate. At the same time he did not think there was any obligation on the part of Zeiss to explain what materials he employed. If Prof. Abbe chose to communicate the fact that fluorite was one of the elements so employed, that was a matter of great scientific interest, and if other opticians availed themselves of the use of the mineral the construction of Microscope objectives would doubtless make great progress.

Mr. Nelson said he saw several glasses of foreign construction very shortly after Zeiss's were introduced; they were made as copies of Zeiss's and were apochromatic, and although they were of great excellence, they did not appear to be so well corrected as Zeiss's. He had no doubt that certain German opticians had found out the secret of Zeiss's apochromatic constructions, though their workmanship was not equal to Zeiss's.

Mr. T. F. Smith said it had been known to him for some time that some mineral had been used in the construction of these lenses, which gave results not previously obtained with glass.

Mr. Mayall said it might be advisable to correct an error by Dr. Pelletan in his description of the new lens; he mentioned the price as 10,000 francs or 400*l*. It appeared that the fact was, as suggested by Mr. Crisp at the time, an extra zero had been added; the actual price was 1000 francs or 40*l*.

Mr. C. H. Gill read a paper "On some methods of preparing Diatoms so as to clearly exhibit the nature of their markings." He illustrated the subject with numerous photomicrographs.

Mr. Crisp thought the appearances shown by these photographs were so striking that it would be very useful if they could publish a selection of them in the Journal. They would there be of great value and interest to the Fellows of the Society.

Prof. Bell agreed with this suggestion, and said they would publish a plate in the June number of the Journal.

Mr. P. Braham exhibited and described a new form of oxyhydrogen lamp adapted for microscopical purposes, the lamp being so mounted as to be used in any position above or below the object. Its application to photomicrography was demonstrated in the room.

Mr. Mayall mentioned that Mr. Clarkson, who had made a special study of appliances for the use of compressed gases, had brought another of the same lamps for inspection, separate from the photographic arrangement.

The Chairman in closing the meeting thought the Society was to be congratulated upon their new rooms, in spite of their being rather cold and a little too resonant—defects which would no doubt prove to be capable of remedy.

The next Conversazione of the Society was announced for the 30th April.

The following Instruments, Objects, &c., were exhibited:—

Mr. F. Crisp:—(1) Nachet's Microscope; (2) Pellin's Microscope.

Mr. P. Braham:—(1) New Oxyhydrogen Lamp; (2) Microscope for photomicrographic work.

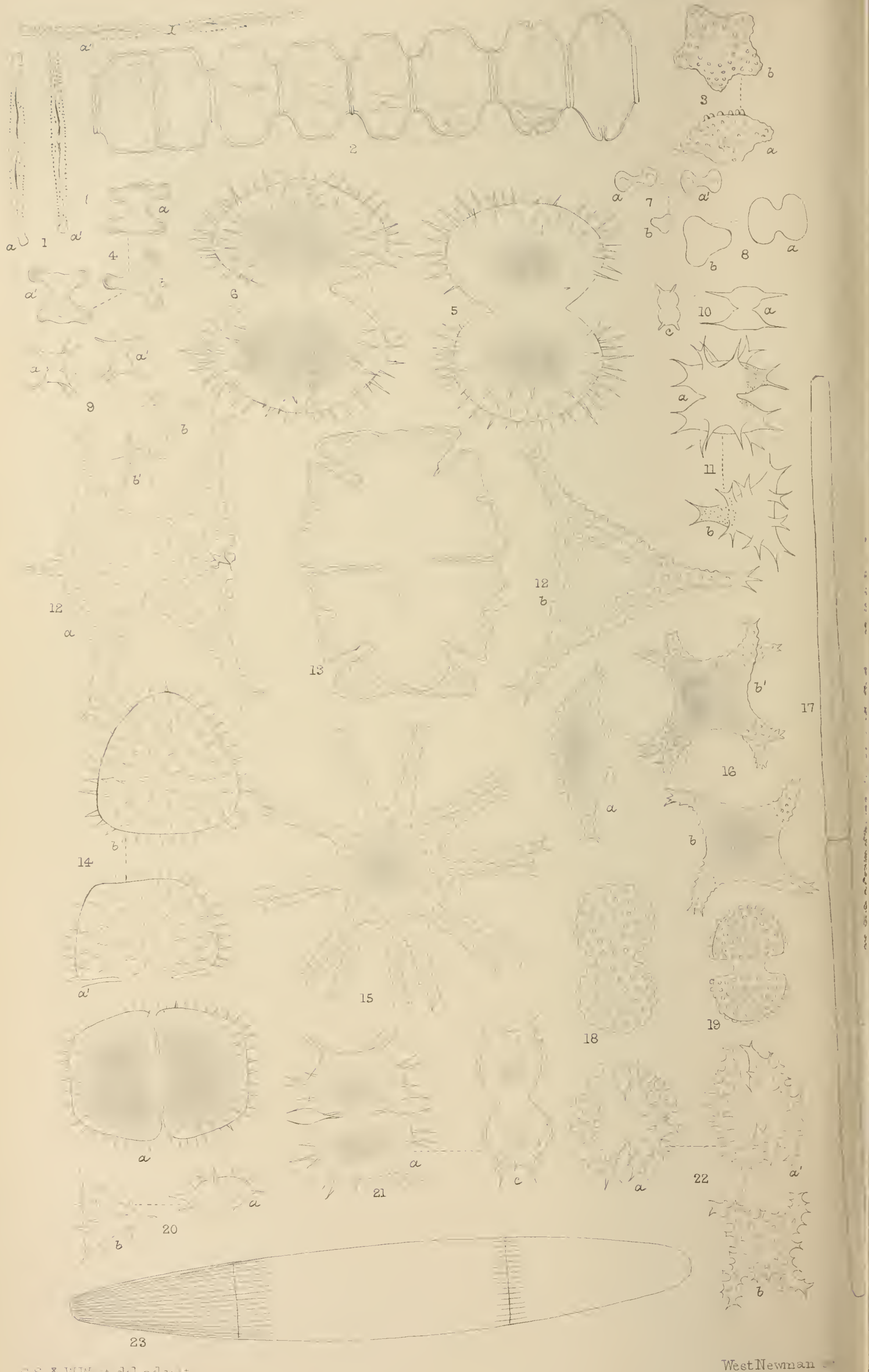
Mr. C. Clarkson:—Braham's New Oxyhydrogen Lamp, on stand, with universal adjustments.

Colonel O'Hara:—Entozoon.

Mr. C. Rousselet:—Rotifers.

Mr. C. H. Wright:—British Hymenolichen.

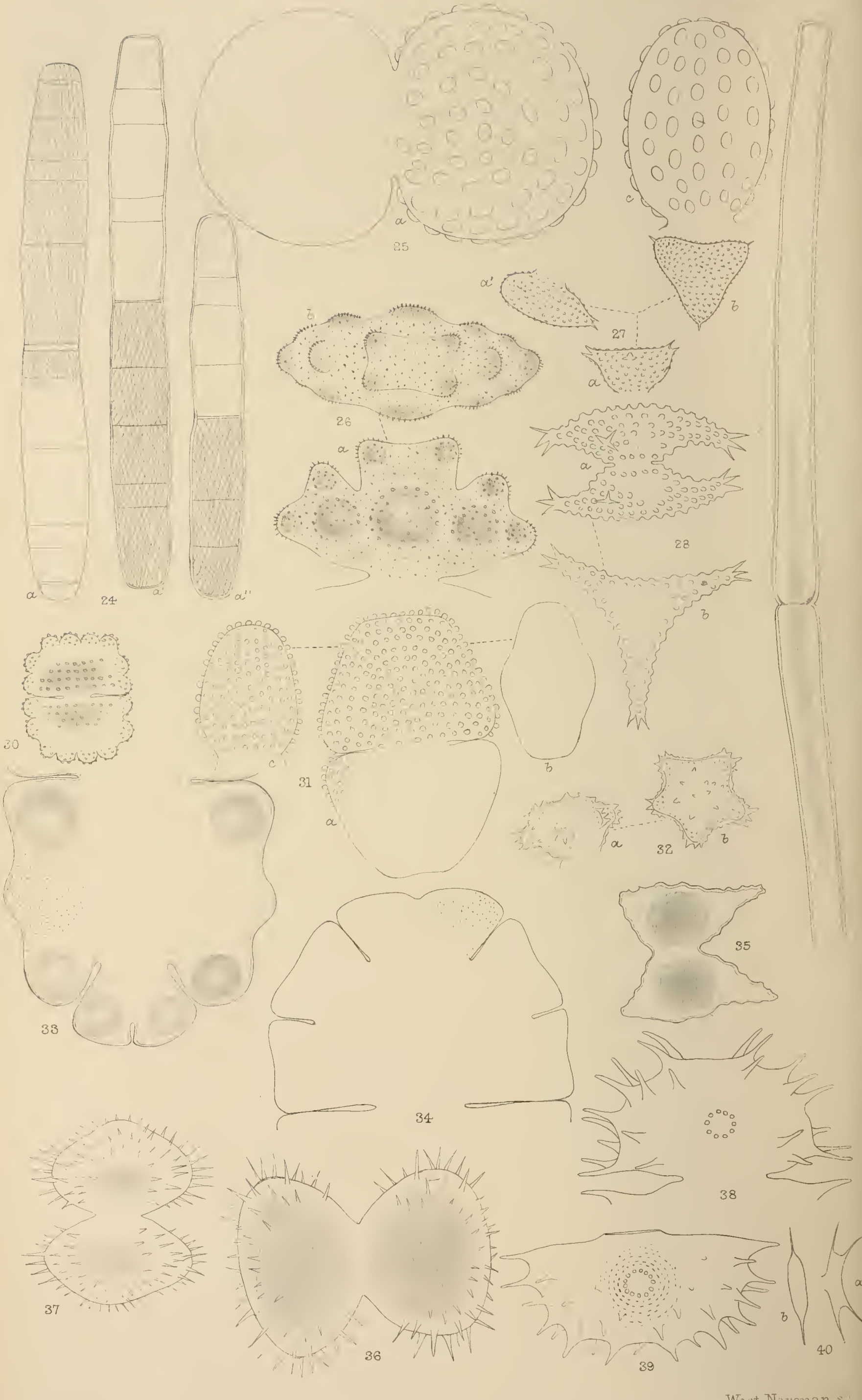
New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. A. F. Bilderbeck-Gomess, F. W. Crick, M.D., J. M. Kirk, J. M. McMahan, J. More, Jun., E. M. Nelson, L. Stevens, W. H. Youdale, and Rev. Harward Turner, B.Sc.



G.S. & W. West del. ad nat.

West Newman sc.

Desmids of North Wales



G.S. & W. West del ad nat.

West, Newman sc.

Desmids of North Wales.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1890.

TRANSACTIONS OF THE SOCIETY.

V.—*Contribution to the Freshwater Algæ of North Wales.*

By Wm. West, F.L.S., Lecturer on Botany and Materia Medica at the Bradford Technical College.

(*Read* 16*th April*, 1890.)

Plates V. and VI.

In 1881, an excellent list of species of Desmids found at Capel Curig was published in the 'Midland Naturalist' by Mr. A. W. Wills. Since then my esteemed and enthusiastic friend Mr. J. H. Lewis, F.L.S., of Liverpool, has most kindly sent me many good and repeated gatherings which he has made at the same place, as well as at Festiniog, Dolgelly, Llyn Padarn, Dolbadarn Castle, Llandudno, Moel Fammau, and on Snowdon. I have also to thank my son, G. S. West,

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EXPLANATION OF PLATES V. AND VI.

(Explicatio iconum.)

a = front view (a fronte visa).
b = vertical view (a vertice visa).
c = side view (a latere visa).

All the figures are drawn from nature to a uniform scale of 400 diameters (icones omnes 400/1).

Plate V.

Fig. 1.—*Gonatozygon minutum* nov. sp.
„ 2.—*Desmidium coarctatum* Nord. var. *cambricum* nov. var.
„ 3.—*Staurastrum margaritaceum* Meneg. var. *coronulatum* nov. var.
„ 4.— „ *bacillare* Bréb. β *obesum* Lund.
„ 5.— „ *cumbricum* nov. sp.
„ 6.— „ „ „ var. *cambricum* nov. var.
„ 7.— „ *osteonum* „
„ 8.— „ *coarctatum* Bréb. var. *subcurtum* Nord.
„ 9.— „ *iotanum* Wolle.
„ 10.—*Arthrodesmus tenuissimus* Arch.
„ 11.—*Staurastrum furcatum* Ehrb. var.
„ 12.— „ *anatinum* Cooke & Wills.
„ 13.—*Micrasterias Americana* (Ehrb.) Ralfs var. *Lewisiana* nov. var.
„ 14.—*Staurastrum muricatum* Bréb. var. *acutum* nov. var.
„ 15.— „ *Ophiura* Lund. forma *nonaradiata*.
„ 16.— „ *cyrtocerum* Bréb. forma *tetragona*.

for the large and most varied gatherings which he made his chief object during two summer holidays spent in this rich district; it is in fact entirely owing to his gatherings that I have been induced to write this paper, and as he has also rendered me the most valuable help during the preparation of this article, I tender him my hearty thanks. His gatherings were made at many places, the following being the chief:—Snowdon, Llyn Idwal, Llandudno, Llyn Ogwen, Bethesda, Bettws-y-coed, Llanfairfechan, Penmaenmawr, Twll Du, Aber, and the following places in Anglesea:—Llyn Coron, Bodorgan, Newborough Rabbit Warren, Maltraeth Yard, and Holyhead. Of course he could not resist also making a large series of gatherings at that happy hunting ground first investigated by Mr. Wills, namely Capel Curig, which is certainly about the richest locality ever found in Britain.

The species mentioned for Twll Du were collected at an elevation of 2000 feet.

The gelatinous investment noticed in many species was especially conspicuous in *Cosmarium Scenedesmus* Delp., *Staurastrum Sebaldi* Reinsch, and *S. longispinum* Bail., the investment round the latter being relatively larger than, and quite as conspicuous, as that of *S. tumidum* Bréb.

The gathering at Llyn Coron proved to be the richest in diatoms; it was chiefly from washings of *Elatine Hydropiper* and *E. hexandra.* Some rare species were obtained from washings of *Dicranum fulvellum* (Dicks.) Sm. and *Nardia emarginata* Ehrb., which were collected at over 2000 feet on Snowdon.

Fig. 17.—*Docidium elongatum* nov. sp.
„ 18.—*Cosmarium orbiculatum* Ralfs.
„ 19.— „ *isthmium* nob.
„ 20.—*Staurastrum spiniferum* nov. sp.
„ 21.—*Xanthidium cristatum* Bréb. var. *spinuliferum* nov. var.
„ 22.—*Staurastrum controversum* Bréb. var.
„ 23.—*Closterium striolatum* Ehrb. forma *recta.*

PLATE VI.

Fig. 24.—*Penium spirostriolatum* Bark.
„ 25.—*Cosmarium tetraophthalmum* (Ktz.) Bréb. var. *subrotundum* nov. var.
„ 26.—*Euastrum verrucosum* Ehrb. var.
„ 27.—*Staurastrum denticulatum* (Näg.) Arch.
„ 28.— „ *dubium* nov. sp.
„ 29.—*Docidium* sp.
„ 30.—*Cosmarium cœlatum* Ralfs. var. *hexagonum* nov. var.
„ 31.— „ *controversum* nov. sp.
„ 32.—*Staurastrum margaritaceum* Meneg. var.
„ 33.—*Euastrum crassum* Ktz. var.
„ 34.—*Micrasterias Jenneri* Ralfs. var. *simplex* nov. var.
„ 35.—*Staurastrum proboscideum* Bréb. var. *subglabrum* nov. var.
„ 36.— „ *cumbricum* nov. sp.
„ 37.— „ „ „ var. *cambricum* nov. var. forma *minor.*
„ 38.—*Xanthidium Brebissonii* Ralfs, forma.
„ 39.— „ *aculeatum* Ehrb., forma.
„ 40.—*Arthrodesmus octocornis* Ehrb., var.

As I do not want to make a repetition of lists, I enumerate none of the species that were recorded in the list of Mr. Wills, except where they are from new localities. I have seen, from other localities, all comprised in his list, except the fourteen species and one variety which follow:—

Desmidium cylindricum Grev. (*Didymoprium Grevillei* Ktz.), *Micrasterias oscitans* (Hass.) Ralfs, *M. pinnatifida* (Ktz.) Ralfs, *M. angulosa* Hantsch, *Euastrum binale* Ralfs var. *angustatum* Wittr., *Cosmarium Nymannianum* Grun., *C. variolatum* Lund., *C. Holmiense* Lund. var. *læve* N. & W., *C. cambricum* Cke. & Wills, *C. coronatum* Cke. & Wills, *Closterium attenuatum* Ehrb., *Penium Nägelii* Bréb., *Staurastrum læve* Ralfs, *S. cristatum* Näg., *S. grande* Buln.

Dr. Cooke also records the following for "North Wales" or "Wales" in his British Desmids:—*Desmidium quadrangulatum* Ralfs ("Wales"), *Closterium Pritchardianum* Arch. ("Wales"), *Micrasterias Crux-melitensis* (Ehrb.) Meneg. ("Wales"), *Euastrum rostratum* Ralfs ("Wales"), *Cosmocladium saxonicum* De Bary, *Cosmarium pseudo-nitidulum* Nord. var. *obsoletum*, *C. læve* Rabh. var. *septentrionale* Wille, *C. Turpini* Bréb. and var. *cambricum* Josh., *Calocylindrus attenuatus* (Bréb.) ("Wales"), *C. turgidus* (Bréb.) Kirch. ("Wales"), *Staurastrum furcatum* (Ehrb.) Pritch. var. *candianum* Delp., *S. subcruciatum* Cke. & Wills.

I also saw the following species from Capel Curig, which are not new records, but are here enumerated to make this list as complete as I am able:—*Sphærozosma vertebratum* Ralfs, *Docidium nodosum* Bail., *Spirotænia obscura* Ralfs, *Micrasterias fimbriata* Ralfs, *M. radiosa* Ag., *Euastrum gemmatum* Bréb., *Calocylindrus connatus* Kirch., *Staurastrum megacanthum* Lund., *S. aristiferum* Ralfs, *S. Sebaldi* Reinsch, *S. vestitum* Ralfs, *S. longispinum* Bail., *S. brasiliensis* Lund., *S. Ophiura* Lund., *S. Cerastes* Lund., *S. Artiscon* (Ehrb.) Lund., *S. furcigerum* Bréb., *S. arachne* Ralfs, *S. tetracerum* Ralfs, *Dimorphococcus lunatus* Braun, *Cœlastrum cambricum* Arch., *Characium Sieboldi* Braun.

I therefore believe that the following list, together with the species just enumerated, will form a tolerably complete list of those species of Freshwater Algæ hitherto observed for North Wales.

The classification here adopted is a modification of the one in Bennett and Murray's 'Cryptogamic Botany'; it has been selected after much consideration, and practically differs but little from their arrangement; it is also not very far removed from that of Goebel. Satisfactory linear arrangement seems impossible.

The many examples of *Micrasterias furcata* Ag. which were seen agreed well with the figures given by Ralfs, but none were seen which tallied with those in Cooke's 'British Desmids.' An example was observed which had been dividing, and which had the new half approaching very closely to *M. Crux-melitensis* (Ehrb.) Meneg.

A variety of *Euastrum verrucosum* Ehrb. with a more gaping sinus than usual, and a sub-rectangular polar lobe, is figured, fig. 26.

As the figures of *Staurastrum anatinum* Cooke & Wills, as published by Cooke differ so greatly, I thought it best to give a figure of the form which was abundantly seen from Capel Curig; Cooke's figure in 'Grevillea' is nearer the form herein figured than the one in his 'British Desmids,' fig. 12. The extremities of the processes often appear as in fig. 12 *d*, caused by the spines being placed somewhat vertically over each other.

A figure of a *Docidium* is given which I have not been able to identify satisfactorily. Fig. 29.

Those species and varieties prefixed by an asterisk are hitherto unrecorded for Britain.

Since this was in manuscript, two of the species which would have been new records for Britain, have been published as occurring in Northern Scotland, by Mr. Roy ('Scottish Naturalist,' Jan. 1890). These interesting species are *Cosmarium subcrenatum* Hantsch, and *C. contractum* Kirch.

The following contractions are used for the chief localities:— A. for Llyn Coron, Anglesea; Do. for Dolbadarn Castle; B. for Bethesda; F. for Festiniog; C. for Capel Curig; P. for Llyn Padarn; D. for Dolgelly; S. for Snowdon.

ALGÆ.

Class Florideæ.

Order Helminthocladieæ.

Genus *Batrachospermum* Roth.

B. moniliforme Roth. A., C.
B. vagum (Roth.) Ag. B.

Class Convervoideæ Heterogamæ.

Order Œdogoniaceæ.

Genus *Œdogonium* Link.

Œ. cryptoporum Wittr. F.
Œ. pluviale Nord. C.
Œ. tenellum Ktz. C.

Several other species of this genus were seen, but not in proper condition for satisfactory identification.

Genus *Bulbochæte* Ag.

B. setigera Ag. C., A., Llyn Idwal.
B. rectangularis Wittr. C.

Class Confervoideæ Isogamæ.

Order Confervaceæ.

Genus *Conferva* (Linn.) Link.

C. fontinalis Berk. Llandudno.
C. tenerrima Ktz. A., Do., F., Llyn Idwal.
C. bombycina Ag. Llyn Idwal.

Genus *Microspora* Thur.

M. fugacissima Thur. A., C., Do.
M. vulgaris Rabh. S., Do.
M. floccosa Thur. F., Aber.

Genus *Cladophora* Ktz.

C. glomerata (Linn.) Ktz. Llanfairfechan.

Genus *Chætophora* Schrank.

C. elegans (Roth.) Ag. B.

Order Ulvaceæ.

Genus *Enteromorpha* Link.

E. intestinalis (Linn.) Link. Maltraeth Yard.

Order Ulotrichaceæ.

Genus *Ulothrix* Ktz.

U. tenerrima Ktz. C., B.
U. radicans Ktz. C., Bettws-y-coed, Conway Castle.

Genus *Hormiscia* Aresch.

H. moniliformis (Ktz.) Rabh. A.
H. zonata (Web. & M.) Aresch. A., C.
H. æqualis (Ktz.) Rabh. var. *catenæformis* Ktz. C.
H. bicolor (Eng. Bot.). Llanfairfechan.

Order Chroolepideæ.

Genus *Microthamnion* Näg.

M. vexator Cooke. C., Holyhead.

Class Conjugatæ.

Order Mesocarpaceæ.

Genus *Mesocarpus* Hass.

M. depressus Hass. Do.
M. parvulus (Hass.) De Bary. C., P., S.
var. *angustus* Hass. C., A.
M. scalaris (Hass.) De Bary. S.
M. pleurocarpus De Bary. A.

Genus *Staurospermum* Ktz.

S. viride Ktz. P.

Order Zygnemaceæ.

Genus *Spirogyra* Link.

S. crassa Ktz. B.
S. nitida (Dillw.) Link. A.
S. longata Vauch. B., P., Aber.
S. flavescens Cleve. Do., P., C.
S. Weberi Ktz. C.
S. tenuissima Hass. C.

Genus *Zygnema* Ktz.

Z. cruciatum (Vauch.). B., C.
Z. stellinum (Vauch.) Ktz. C., A.
Z. Vaucherii Ag. B., Llyn Idwal.
Var. *subtile* Rabh. Llyn Idwal.
Z. anomalum (Hass.). S., B., Bettws-y-coed.

Genus *Zygogonium* Ktz.

Z. ericetorum De Bary var. *terrestre* (*Z. ericetorum* Ktz). Frequent.

Var. *aquaticum* (*Z. Agardhii* Rabh.). Frequent.

Order Desmidiaceæ.

Genus *Gonatozygon* De Bary.

**G. pilosum* Wolle. C.

This was only 11 μ in diameter, Wolle's were 15 μ.

G. Ralfsii De Bary. P.
G. Brebissonii De Bary. Do., B., P.
G. minutum nov. sp. Fig. 1.

G. cellulis subcylindricis, apicem versus angustatis, utroque polo constrictis, vicies longius quam latum, cytodermate dense subgranulato.

Lat. medio, $3 \cdot 7$ μ; infra apices, $2 \cdot 5$ μ.

About twenty times as long as broad, slightly swollen towards the middle and constricted under the apices, cytoderm densely but slightly granulate. C.

I have also collected this species at Brothers Water, in Westmoreland, and at Riccall, in the East Riding of Yorkshire.

Genus *Sphærozosma* Corda.

S. excavatum Ralfs. S., P., Do.
S. pygmæum Cooke. C., Do.

**S. depressum* (Bréb.). (*Spondylosium depressum* Bréb.). C., Do.

Lat. 10 μ.

S. pulchellum (Arch.). (*Spondylosium pulchellum* Arch.). S.

Genus *Onychonema* Wallich.

O. Nordstedtiana Turn. C.

Genus *Hyalotheca* Ehrb.

H. dissiliens (Sm.) Bréb. Common.

This was seen with zygospores from Capel Curig.

Var. *minor* Delp. C.

H. mucosa Mert. P., Do.

**H. undulata* Nord. C.

Lat. 7·5–9 μ; long. 13·5–16 μ.

Genus *Gymnozyga* Ehrb.

G. moniliformis Ehrb. (*Bambusina Brebissonii* Ktz.). A., S., Do., F., D.

Genus *Desmidium* Ag.

**D. coarctatum* Nord. var. CAMBRICUM nov. var. Fig. 2.

Var. cellulis brevioribus et apicibus latioribus.

Long. 22·5–27 μ; lat. 42–45 μ; lat. isthmi 35–37·5 μ; lat. apic. 17·5–20 μ; crass. 35 μ.

This chiefly differs from the type in the cells being shorter and having broader apices. C.

This variety is somewhat doubtfully placed under this species, which it seems to connect with *Desmidium cylindricum* Grev., the shape of the cells in front view being nearer the latter, but the breadth of the apices bringing it nearer the former. The side view shows the apices to be only about half the thickness of the cells, corresponding in this respect with *D. coarctatum* Nord. (in 'Freshwater Algæ of New Zealand and Australia,' p. 25, plate ii. fig. 3), with which it also agrees in having the constriction reduced to a mere retuseness in the side view. It differs from *D. quadratum* Nord. in the form of the cells in side view, as well as in the relative breadth of the apices in the same view, and it is well distant from *D. graciliceps* (Nord.) Lagerh. and *D. majus* Lagerh. in the different shape of its cells. *D. laticeps* Nord. has the same length of cells, but their breadth and thickness is almost twice as great, and the apical breadth is three and a half times as great.

D. Swartzii Ralfs. A., D.

D. aptogonium Bréb. Do., A., S., P.

Genus *Docidium* Bréb.

D. coronatum Bréb. C.

Long. 430 μ; lat. 38–40 μ.

D. Ehrenbergii Ralfs. P., Do., Penmaenmawr.

Some peculiar and large forms of this species were noticed which were somewhat inflated towards the base of the semicells.

Long. 448 μ; lat. medio 32·5 μ.

var. *granulatum* Ralfs. C.

var. ELONGATUM nov. var.

25plo longius quam latum.

Long. 575 μ; lat. medio semicellularum 22·5 μ.

This variety has the frond about twenty-five times longer than broad. C.

D. clavatum Ktz. Do., A., B.

D. nodulosum Bréb. Do.

D. truncatum Bréb. P.

D. baculum Bréb. A., Do.

D. minutum Ralfs. Do.

*var. *gracile* (Wille). (*Penium minutum* Cleve *β gracile* Wille).

Long. 182 μ; lat. 9–10 μ. C.

D. ELONGATUM nov. sp. Fig. 17.

D. quadragies longius quam latum, ad utrumque polum sensim attenuatum, apicibus truncatis, medio non inflato.

Long. 330 μ; lat. medio 8·5–9 μ; ad apicem 6 μ.

Frond about forty times as long as broad, the straight sides gradually tapering from the uninflated base of each semicell to the truncate apex. C.

Genus *Closterium* Nitzsch.

C. didymotocum Corda. P., Do.

Lat. 28–42 μ.

C. obtusum Bréb. C.

Lat. 12·5 μ.

C. lunula Ehrb. D., Do.

C. acerosum (Schrank.) Ehrb. Do., A., D., B.

C. lanceolatum Ktz. C., Do.

C. turgidum Ehrb. A., D., S.

C. prælongum Bréb. C.

C. macilentum Bréb. C.

Lat. 11 μ.

C. gracile Bréb. D., Do.

C. Ehrenbergii Meneg. Moel Fammau.

C. moniliferum Ehrb. F., B., S.

C. Jenneri Ralfs. P., Do., F.

C. Leibleinii Ktz. P., A., B.

C. Dianæ Ehrb. Frequent.

C. Venus Ktz. D., P., Do., A., C.
C. cynthia Not. P.
Lat. 13 μ.
C. Archerianum Cleve. C., P.

Specimens of this were observed from Llyn Padarn up to 25 μ in diameter.

C. costatum Corda. D., Do., P.
C. decorum Bréb. C.
C. striolatum Ehrb. D., P., Do., A., B.
forma *recta*, fig. 23.
Non curvata, rectissima.
Lat. 33 μ.

This differs from the type in having no curvature; several examples were seen, and were turned over and over. P.

C. intermedium Ralfs. P., Do.
C. angustatum Ktz. D., F.
C. juncidum Ralfs. P., Do., D.
C. lineatum Ehrb. D., S.
C. rostratum Ehrb. Do., P., A.
C. setaceum Ehrb. P., Do.
C. Kützingii Bréb. A., P.
C. Cornu Ehrb. Do.
*forma *major* Wille. C.
C. acutum Bréb. Do., S. D.
C. subulatum (Ktz.). C.

Genus *Penium* Bréb.

P. margaritaceum Bréb. P., B., Do., A., Llyn Idwal.
Lat. 11–25 μ.
var. *punctatum* Ralfs. P.
P. cylindrus Bréb. P., Do., F. B.
P. spirostriolatum Bark. C., P., F. Fig. 24.

As this species appears to vary in different localities, some figures are given.

I also give the dimensions of some of the figures that were drawn.

I have noticed this variability from Maine, N. Ireland, Scandale in the Lake District, and Glen Shee and Craig an Lochan in Scotland. The *parallel* striæ can often be seen on both the upper and under surfaces of the empty cylindrical frond, and then they appear as if they crossed each other.

22·5 × 188 μ from Festiniog.
23·5 × 182 μ from Llyn Padarn.
19 × 202 μ from Capel Curig.
20 × 227 μ from ., „
22·5 × 130 μ from Festiniog.
25·5 × 128 μ from Capel Curig.

P. digitus Bréb. S., D., P., Do., B., F.
P. interruptum Bréb. Do.
P. closterioides Ralfs. A., Do.

This species sometimes has one or two bands, which show as distinct papillæ on the margin of the central part of the cell.

A small form was also seen; long. 98 μ, lat. 22 μ.

P. navicula Bréb. Do., F.
P. Brebissonii Ralfs. Common.
P. oblongum De Bary. S.
P. truncatum Bréb. F., B., Twll Du.
P. Mooreanum Arch. B.
P. minutissimum Nord. C., F.
P. cucurbitinum Bisset. S.

Genus *Cylindrocystis* Meneg.

C. diplospora Lund. F., C., B., Llyn Idwal.
C. crassa De Bary. C., B., F., D.

Genus *Tetmemorus* Ralfs.

T. Brebissonii Ralfs. Common.
var. β *turgidus* Ralfs. S.
var. γ (De Bary) Arch. Twll Du.
T. granulatus Ralfs. Common.
T. lævis Ralfs. S., Do., D., F., Twll Du.

Genus *Spirotænia* Bréb.

S. condensata Bréb. F., P., Do., D.
S. truncata Arch. C.
Long. 50 μ; lat. 12·5 μ.

Genus *Micrasterias* Ag.

M. mucronata (Dixon) Rabh. D., S.
M. americana (Ehrb.) Ralfs. S.
var. *recta* Wolle. Do.
var. LEWISIANA nov. var. Fig. 13.
Var. lobis polaribus subintegris et latioribus, incisuris angustioribus infra lobos polares.

This has the end lobes subentire and wider, the infra-apical incisions are narrower also than in the var. *recta* Wolle, which it approaches. P.

This is a very distinct variety, and very distant from "forma *major* Reinsch," with which it is worth comparing, as this latter seems to be at the other extreme.

M. denticulata Bréb. D., S., P., Do., B.
M. rotata (Grev.) Ralfs. P., Do.

M. papillifera Bréb. P., Do.

A form of this was often seen from Llyn Padarn with cells always longer than broad.

M. truncata Corda. P., A., Do., S.

A form of this species was seen from Llyn Padarn, which might be termed glanduliferous, as each tip of the divisions bears an apparent gland. Another peculiar variety of this species was seen with a gaping sinus and narrower isthmus.

M. crenata Bréb. Do., B.
M. Jenneri Ralfs. D.
var. SIMPLEX nov. var. Fig. 34.
Var. lobis quinque semicellulæ leviter concavis et incisuris brevioribus.

This chiefly differs from the type by having each of the five lobes of the semicell but slightly concave, and the incision not so deep. D.

Genus *Euastrum* Ehrb.

**E. verrucosum* Ehrb. var. *simplex* Josh. A.
Long. 65 μ; lat. 60 μ; lat. apic. 27–30 μ.
E. oblongum Grev. Do., S., D., B., P.
E. crassum Ktz. D.

A form of this was frequent, which had a marked protuberance about half-way up the side of the front view of each semicell. Fig. 33.

E. pinnatum Ralfs. C.
E. humerosum Ralfs. P.
E. ventricosum Lund. D.

This rare species was in great abundance in a gathering made by J. H. Lewis at Dolgelly.

Long. 80–95 μ; lat. 52–60 μ; crass. 27–29 μ.
E. affine Ralfs. C., B., Do., P.
E. ampullaceum Ralfs. P.
E. insigne Hass. D., S.
E. didelta Ralfs. S., P., Do., A., B., D.
E. cuneatum Jenner. A., S., F., Llyn Idwal.
E. ansatum (Ehrb.) Ralfs. S., P., B., D., Do., F.
E. sinuosum Lenor. S., C.
E. pectinatum Bréb. P., A., D., B.
E. elegans Bréb. Do., S., P., A., F.
var. *bidentata* Näg. C., P., B.
**E. pseudelegans* Turn. C.

This had the five central markings confluent; it also had the

second from each end of the four marginal markings somewhat indistinct.

E. crassicolle Lund. C., D., P.
Long. 28 μ; lat. 15 μ.
E. binale Ralfs. F., A., Do., B, P., Llyn Idwal.
var. *elobatum* Lund. C., S., F., D., B.
forma *minor* W. West. F., C.
Long. 10 μ; lat. 7·5 μ.
E. denticulatum (Kirch.) Gay. C., P.
E. venustum Bréb. C.

Genus *Cosmarium* Corda.

C. sublobatum (Bréb.) Arch. Bettws-y-coed, Twll Du.
C. quadratum Ralfs. S.

Specimens of this were seen 42 μ by 62 μ.

C. plicatum Reinsch. S.
var. *sinuosum* Lund. C.
C. Hammeri Reinsch. D.
C. homalodermum Nord. S.
C. anceps Lund. F.
C. granatum Bréb. P., B.
C. cucumis Corda. B, S., Llyn Idwal.
C. circulare Reinsch. S.
Long. et lat. 58 μ.
C. Ralfsii Bréb. S., A., D., Do., F.
C. pyramidatum Bréb. F., B., A., Do.
C. pseudopyramidatum Lund. B., A.
C. galeritum Nord. A.
C. pseudonitidulum Nord. Bettws-y-coed.
C. nitidulum Not. B.
C. subtumidum Nord. B.
Long. 31 μ; lat. 27·5 μ; crass. 16 μ.
**C. tumidum* Lund. C.
Long. 30–33 μ; lat. 27–29 μ.
C. Phaseolus Bréb. Llyn Ogwen.
**C. Scenedesmus* Delp. C.
C. gotlandicum Wittr. C.
C. bioculatum Bréb. B., P., S., D., F., A.
C. tinctum Ralfs. B., F., P., A.

A form of this was seen with the vertical view having the middle somewhat tumid, like that of *C. tinctum* Ralfs β *intermedium* Nord., as described and figured in his 'Freshwater Algæ of New Zealand and Australia,' published in Stockholm, 1888.

C. pygmæum Arch. C.
C. truncatellum Perty. B.

C. exiguum Arch. C.
C. Meneghinii Bréb. D., B., P., S., Do.
var. *angulosum* (Bréb.) Rabh. (*Cosmarium angulosum* Bréb.). A.
*var. *simplicissimum* Wille. A.
C. striatum Boldt. A.

This rare species has been previously noticed in Scotland.

C. Regnesii Reinsch. C.
C. crenatum Ralfs. Do., B.
C. undulatum Corda. B., A.
C. tetragonum Näg. Bettws-y-coed.
var. *Lundellii* Cooke. C.
C. tetraophthalmum (Ktz.) Bréb. P., B., Do.

The form of this figured by Cooke has fewer granules than that given by Ralfs; the Welsh forms noticed were nearer the figures of the latter, but the forms I see more often have generally a few more—though rather smaller—granules than the figure of Ralfs, and the semicells are somewhat *subpyramidal* and *shortly subtruncate*, hardly "semiorbicular."

var. SUBROTUNDUM nov. var. Fig. 25. Newborough Warren.

Var. sinu apertissimo semicellulis subrotundis facto.
Long. 137 μ; lat. 79 μ; isth. 20 $\mu \times 35$ μ.

This differs from the type in the open sinus caused by the subrotund semicells.

C. Brebissonii Meneg. B., D., P., Do., Newborough Warren.
C. conspersum Ralfs. B., D., A.
C. quadrum Lund. C.
C. quaternarium Wittr. & Nord. P.
C. margaritiferum (Turp.) Meneg. B., P., S., A., Llandudno.
C. Portianum Arch. C., P., A., Do.
C. reniforme (Ralfs) Arch. C.
C. Logiense Biss. B., Bettws-y-coed.
C. punctulatum Bréb. C., B., S., P., Twll Du.
var. *rotundatum* Klebs. S.
Long. 35 μ; lat. 28 μ.
C. Blyttii Wille. C., P.
C. orthostichum Lund. C.
C. botrytis Meneg. Common.
C. præmorsum Bréb. Do., A.
C. biretum Bréb. D.
Long. 75 μ; lat. ad apices 61 μ; lat. isth. 17·5 μ.
C. CONTROVERSUM nov. sp. Fig. 31.
C. medium, granulatum, dimidiam partem circa longius

quam latum, sinu anguste lineari, semicellulis truncato-pyramidatis, granulis concentrice ordinatis, a vertice subtruncato-ellipticis elevatione centrali lata, a latere obtuso-ovatis.

Long 88 μ; lat. 60 μ; lat. isthmi 23 μ.

Frond granulate, about one-half longer than broad, sinus deep and linear, semicells truncately pyramidal, end view elliptic with a broad elevation at each side, side view obtusely ovate, granules arranged somewhat concentrically. C.

This approaches *C. ochthodes* Nord. in form; it also has some resemblance to large forms of *C. botrytis* Meneg., but the end and side views at once distinguish it from these species. It was very sparingly seen.

C. Broomei Thw. S., C., B. Do.
C. ochthodes Nord. C., S., P. B., Do., Bettws-y-coed.
**C. confusum* Cooke β *regularius* Nord. C.
C. amœnum Bréb. C.
C. Bœckii Wille. C.
C. sphalerostichum Nord. & Wittr. B., C., P.
C. subcrenatum Hantzsch. S.
C. cœlatum Ralfs. B., S., Do., P., Twll Du.
var. HEXAGONUM nov. var. Fig. 30.
Var. cellulis hexagonis, apicibus truncatis tetracrenatis, granulis centralibus in seriebus linearibus ordinatis.
Long. 43 μ; lat. 36 μ; lat. isth. 10 μ.

This differs from the semiorbicular type in having a distinctly hexagonal form, bearing four of the crenatures of each semicell at the truncate ends; the central granules are also arranged in linear series not concentric. C.

C. ornatum Ralfs. B., A.
C. cristatum Ralfs. C.
C. quinarium Lund. C.
C. isthmochondrum Nord. C.
C. quadrifarium Lund. C.
forma *hexasticha* (Lund.) Nord. C.
C. hexalobum Nord. B.
C. cyclicum Lund. S.
C. speciosum Lund. C., Bettws-y-coed.
C. subspeciosum Nord. C.
C. orbiculatum Ralfs. P., Bettws-y-coed. Fig. 18.
**C. isthmium* nob. Fig. 19.
Lat. 25–26 μ.

This is the same as *C. excavatum* Nord. var. *duplo-major* Lund., as described and figured by Wolle (Desm. U.S.A., p. 77, pl. liii. figs. 14 and 15). As I do not believe this species to be a variety of

C. excavatum Nord. (Desm. Brasil., tab. iii. fig. 25), I propose the present suggestive name. A figure of the preceding species is given for comparison with this one. C.

C. moniliforme Turp. S.
C. contractum Kirch. C.
C. globosum Buln. A., S.

Genus *Calocylindrus* De Bary.

C. cylindricus Ralfs. P.
C. pseudoconnatus Nord. B.
C. cucurbita Bréb. Frequent.
C. palangula Bréb. C.
C. Thwaitesii Ralfs. D.
C. curtus Bréb. C., B., F.
C. De Baryi Arch. C.
C. strangulatus Cooke & Wills. C.

Genus *Xanthidium* Ehrb.

X. armatum Bréb. P., D., A., S.
X. aculeatum Ehrb. Do., P., S.
Long. 74 μ; lat. 62–75 μ; from Snowdon.
Long. 64 μ; lat. 62 μ; crass. 28 μ; from Llyn Padarn.

A peculiar form of this is figured, which some may think belongs to the next species by reason of the shape of the basal angles of the semicells; still the spines are scattered in the same way as those of the species under which it is placed. Fig. 39.

X. Brébissonii Ralfs. P.

Fig. 38 represents a form which differs from that usually seen.

X. antilopeum Bréb. C., P., Do.

Large forms of this species were seen from Capel Curig up to 78 μ in diameter.

X. cristatum Bréb. var. SPINULIFERUM nov. var. Fig. 21.
Var. cum quattuor vel quinque spinis parvioribus additis inæqualiter ordinatis intra marginem semicellulæ singulæ.

This has from four to five additional spines rather unequally disposed just within the margin of the front view of each semicell. C.

Genus *Arthrodesmus* Ehrb.

A. octocornis Ehrb. S.

A variety with wide and short cells is figured. Fig. 40.

A. incus Hass. var. *convergens* Arch. C.
var. *divergens* Arch. C., F.

A. convergens Ehrb. C., A.
A. tenuissimus Arch. C.

As this is a rare species, a figure is given. Fig. 10.

Genus *Staurastrum* Meyen.

S. dejectum Bréb. var. *lunatum* Ralfs. P., A.
S. mucronatum Ralfs. C.
S. connatum (Lund.) Roy & Biss. C.
S. apiculatum Bréb. C., A., P.
S. Dickiæi Ralfs. C., P.
S. brevispinum Bréb. C.
S. cuspidatum Bréb. D., F.
**S. pseudocuspidatum* Roy & Biss. C.
S. O'Mearii Arch. S., C., F.
**S. bacillare* Bréb. β *obesum* Lund. C.
Long. 17–18 μ. Fig. 4.
S. oligocanthum Bréb. C.
**S. denticulatum* (Näg.) Arch. F. Fig. 27.
S. avicula Bréb. F.
var. *aciculiferum* W. West. F.
S. furcatum Ehrb. C., F., P.

A faintly punctate variety of this species is figured, having the lateral bifid processes almost reduced to two spines, the other "bifid processes" being sharply bispinate. Fig. 11.

var. *armigerum* Bréb. P., Do.
S. pseudofurcigerum Reinsch. P.
S. Reinschii Roy. F., C.
S. Brébissonii Arch. C.
S. pilosum Näg. Do., B., C., F., P.
S. teliferum Ralfs. P., Do.
**S. gladiosum* Turn. C.
S. SPINIFERUM nov. sp. Fig. 20.

S. parvum, semicellulis ellipticis cum octo spinis (circa) ad marginem semicellulæ singulæ, a vertice triangulare cum spinis novem, lateribus leviter concavis.

Long. 25 μ; lat. 22 μ; lat. isth. 7·5 μ.

Segments elliptic, with about eight spines in the periphery of each segment, end view triangular, sides very slightly concave, showing two spines between each apical one. F.

S. hystrix Ralfs. C.
S. CUMBRICUM nov. sp. Figs. 5 and 36.

S. magnum, tertiam partem longius quam latum, semicellulis late ellipticis, a vertice triangulare; lateribus leviter convexis cum spinis velatis sed paucis ad sinum, multis longioribus ad angulos.

Long. 76–85 μ; lat. 55–65 μ; lat. isthm., 25 μ; spinarum long. ad angulos 11–15 μ.

Frond rather large, one-third longer than broad, semicells broadly elliptical, end view triangular, with slightly convex sides, beset with spines except at the constricted part, many of which are much longer about the apices of the angles. C.

var. CAMBRICUM nov. var. Fig. 6.

Var. semicellulis subangularibus et isthmo angustiori.

Long. 83 μ; lat. 60 μ; lat. isth. 20 μ.

This differs from the type by having the semicells somewhat angular, and the isthmus narrower. C.

var. CAMBRICUM nov. var. forma *minor*. Fig. 37. C.

Long. 62 μ; lat. 48 μ; lat. isthmi 13 μ.

I first noticed this species in a gathering from Lindeth in Westmoreland a few years since, and it has been named in a manuscript for some time. I have since noticed it in a gathering from Capel Curig along with its variety *cambricum*. It differs from *St. Pringsheimii* Reinsch in its larger size, and in its relatively sharper spines of varying lengths. It differs from *St. senticosum* Delponte in being longer than broad, whereas the latter is broader than long, and also has its long spines more uniformly arranged. *St. Notarisii* Delponte differs in having its uniform spines regularly arranged as well as in its narrower sinus. *St. saxonicum* Buln. differs in its relatively broader isthmus and its shorter uniform spines.

S. Pringsheimii Reinsch. P.

S. Royanum Arch. (*S. setigerum* Cleve). C.

S. spongiosum Bréb. B., P., Do.

S. Griffithsianum (Näg.) Arch. C., Do.

S. asperum Bréb. C., F.

S. saxonicum Reinsch. S.

**S. coarctatum* Bréb. var. *subcurtum* Nord. C. Fig. 8.

S. muticum Bréb. B., S.

S. orbiculare Ralfs. A., B., F., P.

S. OSTEONUM nov. sp. Fig. 7.

S. minutum, sinu latissimo et obtuso, semicellulis rotundato-ellipticis, a vertice triangulare, angulis rotundatis et lateribus concavis.

Long. 14 μ; lat. 6·5 μ; lat. isthmi 3 μ.

Minute, front view shaped like a dumb-bell, end view trigonal with slightly concave sides, cytoderm smooth. C.

S. pygmæum Bréb. C., S., F,, Bodorgan.

S. lanceolatum Arch. C.

S. inconspicuum Nord. C.

This characteristic but rare species was often noticed, and it showed no variation.

S. striolatum Näg. C., B.
S. muricatum Bréb. S., Do., A., D.
var. ACUTUM nov. var. Fig. 14.
Var. spinis brevibus (nec granulis), semicellulis truncato-pyramidatis.
Long. 62–70 μ; lat. 48–52 μ.

This differs from the type in the acute though short spines in place of "conic granules," as well as in the trapezoid or truncately pyramidal semicells. S.

This is the form I mentioned in "The Freshwater Algæ of N. Yorkshire" (Journ. Bot., Oct. 1889), as being a distinct form noticed from several places.

S. punctulatum Bréb. Frequent.
S. turgescens Not. F.
S. pileolatum Bréb. D., C.
S. capitulum Bréb. D.
S. Meriani Reinsch. P.

All the specimens seen were 5-ended.

S. alternans Bréb. P., A.
S. dilatatum Ehrb. C., P., Do.
S. tumidum Bréb. P., Do., D.
S. aversum Lund. Llanfairfechan.
S. brachiatum Ralfs. D.
**S. scabrum* Bréb. C.
S. tricorne (Bréb.) Meneg. F., A., S., P.
var. β Ralfs. C.
**S. Haaboeliense* Wille. C.
S. cyrtocerum Bréb. Do.
forma *tetragona*. Fig. 16.
Forma a vertice tetragona. D., Do.
S. inflexum Bréb. S., A., F.
S. polymorphum Bréb. S., B., F. Llyn Idwal.
**S. gracile* Ralfs β *nanum* Wille. C., S.
S. paradoxum Meyen. A., B., Llandudno.
var. *longipes* Nord. A.

A form of this variety was seen with rather longer processes than usual.

S. Ophiura Lund. forma *nonaradiata*. Fig. 15.
Forma a vertice nonaradiata.

End view with nine rays. C.

Of this beautiful species, two forms were noticed along with the type, one, a nine-rayed form, was seen several times, the other, a very long and slender armed one, measured 145 μ across the arms. Cooke

and Wolle describe the end view as 7 (rarely 6 or 8) rayed; the forms from Capel Curig are almost all 8-rayed.

S. proboscideum Bréb. Llyn Ogwen.
var. SUBGLABRUM nov. var. Fig. 35.
Var. margine undulato nec spinis truncatis vestitis, radii apicibus integris.

This differs from the type in being undulately rough and not adorned with truncate spines, as well as in the entire apices of the processes. C.

S. controversum Bréb. D., S., P. Fig. 22.

A figure of a variety of this variable species is given.

S. aculeatum Meneg. P.
S. DUBIUM nov. sp. Fig. 28.
S. submagnum, latius quam longum, scabro-granulatum, semicellulis fusiformibus, constrictione profunda, radiis productis tricuspidatis et inflexis, a vertice triangulare, ad basem semicellulæ cum annulo singulo granulorum.
Long. 40 μ; lat. 70 μ; lat. isth. 13 μ.

This species is nearly twice as broad as long, deeply constricted with rough granules, processes inflexed, granulate and tricuspidate, semicells somewhat fusiform, base annularly granulate, vertical view triangular. C.

This will no doubt prove a controversial species; it is near *S. Manfeldtii* Delp., but smaller and with thicker processes; it is also more regularly granulate. It also comes near *S. pseudosebaldi* Wille, but lacks the basal inflation and the bifurcate spines. The front view is like *S. vestitum* Ralfs, but the end view has not the characteristic spiny adornments of the sides of that species. It is not like *S. Sebaldi* Reinsch, but the end view does approach the var. *ornatum* Nord., as well as the form *novizelandica* Nord. of the latter variety, yet the centre of the concave sides of the end is much rougher, and the processes are thicker than the above-mentioned form as well as shorter than those of the var. *ornatum*, and more inflexed than either. It also has some resemblance to *S. bifurcum* Josh., but the arms are more inflexed, and the outline is more regular. It is also relatively shorter than all these species except *S. vestitum* and one of the original figures of *S. bifurcum.*

S. oxyacanthum Arch. C., B.
S. Sebaldi Reinsch, var. *ornatum* Nord. C.
S. eustephanum (Ehrb.) Ralfs. C.
S. sexangulare Buln. C.

S. sexcostatum Bréb. P., S.
S. margaritaceum Meneg. Do., S., F., B.

A form which showed short spines irregularly disposed at the apices is figured from Capel Curig. Fig. 32.

var. CORONULATUM nov. var. Fig. 3.
Var. cum annulo granulorum parvorum ad apices truncatos semicellularum.

This has the apices of the semicells truncate and bordered by a circle of small granules. P.

**S. iotanum* Wolle. C. Fig. 9.

This tiny species may easily escape observation. Its arms are similar to those of *St. tetracerum* Ralfs, but much finer and more delicate, the end view being also triradiate. Its form in front view is not unlike those of *St. O'Mearii* Arch. and *St. pterosporum* Lund., but it is smaller, and has arms and not spines.

Class MULTINUCLEATÆ.

Order SIPHONEÆ (Cœloblastæ).

Genus *Vaucheria* DC.

V. sessilis Vauch. Penmaenmawr.

Class CŒNOBIEÆ.

Order PANDORINEÆ.

Genus *Pandorina* Ehrb.

P. morum Ehrb. B., C.

Order PEDIASTREÆ.

Genus *Pediastrum* Meyen.

P. angulosum Ehrb. C.
P. Boryanum Turp. A., Do., Llandudno, Bodorgan.
var. *granulatum* Ktz. A., C.
P. bidentulum A. Braun. C.
P. constrictum Hass. A.
P. pertusum Ktz. A.
P. Ehrenbergii A. Braun. A., C.

Order SORASTREÆ.

Genus *Cœlastrum*.

C. microsporum (Näg.) Braun. C.

PROTOPHYTA.

Group Schizophyceæ.

Class Protococcoideæ.

Order Eremobieæ.

Genus *Dictyosphærium* Näg.

D. Ehrenbergianum Näg. C., F., A.

Genus *Botrydina* Bréb.

B. vulgaris Bréb. A.

Genus *Apiocystis* Näg.

A. Brauniana Näg. C.

This species may probably now have a place in the Class Cœnobieæ. An excellent paper has just appeared in the 'Journal of the Linnean Society,' by Mr. S. Le M. Moore, which is well illustrated, new features in its life-history being portrayed, the results of which point to this plant as being "a degenerate type of Volvocineæ." The long cilia which are described should be specially looked for by algal students. Mr. Moore thinks this species has only been seen in England twice before, at Wimbledon and in Cornwall. I have gathered it at Scarborough Mere and Brothers Water; it is also on record for two places in the West Riding. (Since the above was written, Mr. A. W. Bennett has stated in this Journal that Mr. Roy finds it also near Aberdeen. P., 9 Feb. 1890.)

Genus *Nephrocytium* Näg.

N. Agardhianum Näg. C.
N. Nægelii Grun. S., B.

Genus *Ophiocytium* Näg.

O. cochleare Braun. C., B.

Genus *Hormospora* Bréb.

H. transversalis Bréb. C.

Order Protococcaceæ (including Palmellaceæ).

Genus *Protococcus* Ag.

P. viridis Ag. Common.

Genus *Pleurococcus* Meneg.

P. vulgaris Meneg. Common.

Genus *Palmella* Lyngb.

P. mucosa Ktz. C.
P. hyalina Bréb. F., C.

Genus *Chlorococcum* Fries.

C. gigas Grun. P.

Genus *Glœocystis* Näg.

G. ampla Ktz. B., A., P.
G. vesiculosa Näg. Do., Bettws-y-coed.
G. rupestris Rabh. Llyn Idwal.
G. botryoides Ktz. C.

Genus *Schizochlamys* A. Br.

S. gelatinosa A. Braun. F., Bettws-y-coed.

Genus *Eremosphæra* De Bary.

E. viridis De Bary. C., A.

Genus *Botryococcus* Ktz.

B. Braunii Ktz. A., Penmaenmawr.

Genus *Urococcus* (Hass.) Ktz.

U. insignis (Hass.) Ktz. (*Chroococcus macrococcus* Rabh.). F.

I agree with Nordstedt in considering these two as forming but one species. I have noticed varying forms from N.W. Ireland, Yorkshire, the Lake District, and Scotland.

Genus *Rhaphidium* Ktz.

R. aciculare A. Braun. C., Llyn Idwal.
R. falcatum Corda. C., B., A.

Genus *Scenedesmus* Meyen.

S. obtusus Meyen. C., A., B.
S. acutus Meyen. A., C., S., P.
var. *obliquus* Rabh. B.

S. quadricauda Bréb. A., C., Llandudno.

Genus *Polyedrium* Näg.

P. gigas Wittr. D.
P. tetraedricum Näg. C.
P. longispinum (Perty) Rabh. Bettws-y-coed.
P. enorme (Ralfs) De Bary. C.

Class Cyanophyceæ or Phycochromaceæ.

Sub-class Nostochineæ.

Order Nostocaceæ.

Genus *Nostoc* Vauch.

N. macrosporum Meneg. C.

Genus *Sphærozyga* (Ag.) Ralfs.

S. elastica (Ralfs). F.

Genus *Anabæna* Bory.

A. Smithii (Thur.) Nord. and Wittr. Twll Du.

Order Rivulariaceæ.

Genus *Rivularia* Roth.

R. echinata (Eng. Bot.). Twll Du.

Order Scytonemaceæ.

Genus *Tolypothrix* Ktz.

T. ægagropila Ktz. C.
var. *pygmæa* Ktz. Twll Du.

T. coactilis Ktz. C.

Genus *Scytonema* Ag.

S. myochrous Ag. B., Bettws-y-coed, C.

Genus *Stigonema* Ag.

S. panniforme Ag. C., Twll Du.
S. mamillosum Ag. C.

The last two species are probably lichens.

Order Oscillariaceæ.

Genus *Oscillaria* Bosc.

O. tenerrima Ktz. C.
O. tenuis Ag. C.
O. limosa Ag. P.
O. irrigua Ktz. Do.
O. nigra Vauch. D., Do.
O. Frölichii Ktz. C., Twll Du, Bodorgan.

Genus *Lyngbya* Ag.

L. littoralis Carm.. Llandudno, in a pool near the sea.
L. vulgaris Kirch. A., Do.

Genus *Inactis* Ktz.

I. sp. This occurred at an elevation of about 2000 feet near Twll Du, on dripping rocks, forming large *dark red* patches; the filaments were from 1·2 to 2·5 μ in thickness. It is probably a variety of *I. Cresswellii* Thur. It is certainly different from *I. tinctoria* Thur., which I have recently seen on *Myriophyllum* from the Lake District.

Genus *Spirulina* Link.

S. oscillarioides Turp. C.

Sub-class Chroococcaceæ.

Order Chroococcaceæ.

Genus *Chroococcus* Näg.

C. cohærens Näg. A., F., C., Bettws-y-coed.
C. turgidus Näg. S., C., F., Llyn Idwal.

Genus *Glœocapsa* Ktz.

G. polydermatica Ktz. C.
G. quaternata Ktz. Near Llyn Coron.
G. magma Ktz. Dripping rocks, Twll Du.

Genus *Merismopedia* Meyen.

M. violacea Ktz. · C.
M. glauca Näg. P., C., S.

Genus *Aphanocapsa* Näg.

A. rivularis (Carm.) Rabh. Penmaenmawr.

Genus *Microcystis* Ktz.

M. protogenita (Bias.) Rabh. C.
M. marginata Kirch. C.

Genus *Cœlosphærium* Näg.

C. Kützingianum Näg. C.

Genus *Gomphosphæria* Ktz.

G. aponina Ktz. C.

Class Diatomaceæ.

Genus *Cyclotella* Ktz.

C. operculata Ktz. A.
C. Kützingiana Thw. A.

Genus *Melosira* Ag.

M. varians Ag. Frequent.
M. arenaria Moore. A., C., S.

Genus *Campylodiscus* Ehrb.

C. Echineis Ehrb. (*C. cribrosus* Sm.) var. *Cesatianus* Rabh. A.

Genus *Surirella* Turp.

S. linearis Sm. Do., D., B., C., P., Bettws-y-coed.
S. biseriata (Ehrb.) Bréb. C., A., P., B., Moel Fammau.
S. angusta Ktz. C., P.
S. splendida (Ehrb.) Ktz. C., A.
S. nobilis Sm. Moel Fammau.
S. ovata Ktz. B.
S. minuta Bréb. C., A.
S. pinnata Sm. C., P.
S. gracilis Grun. C.

Genus *Cymatopleura* Sm.

C. Solea (Bréb.) Sm. A.

Genus *Epithemia* Bréb.

E. turgida (Ehrb.) Ktz. A., S., Llandudno, Newborough Warren.
E. Westermanni (Ehrb.) Ktz. Llandudno.
E. granulata Ktz. A.
E. Hyndmanii Sm. A.
E. Sorex Ktz. A.
E. gibba (Ehrb.) Ktz. A., Llandudno, Newborough Warren.
E. ventricosa Ktz. A., Llandudno.
E. Zebra (Ehrb.) Ktz. A.
E. Argus (Ehrb.) Ktz. Llandudno, Newborough Warren.
E. alpestris Sm. A.

Genus *Eunotia* Ehrb.

E. gracilis Sm. A.
E. monodon Ehrb. S.
E. diodon Ehrb. S., P.
E. triodon Ehrb. C.
E. tetraodon Ehrb. C., P.
E. diadema Ehrb. C.

Genus *Himantidium* Ehrb.

H. Arcus Ehrb. S.
H. majus Sm. C., S., Twll Du.
H. gracile Ehrb. B., S., A., C., Do., Llyn Idwal, Twll Du.

H. pectinale Dillw. S.
H. undulatum Sm. C., B.

Genus *Cymbella* Ag.

C. Ehrenbergii Ktz. A.
C. cuspidata Ktz. A., P.
C. turgida Greg. A., C.
C. maculata Ktz. A., B.
C. affinis Ktz. C., B.

Genus *Cocconema* Ehrb.

C. lanceolatum Ehrb. A., S., Do.
C. cymbiforme (Ktz.) Ehrb. A., B.
C. Cistula Hempr. A., Llandudno.
C. parvum Sm. A., S., B.

Genus *Encyonema* Ktz.

E. cæspitosum Ktz. A.

Genus *Amphora* Ehrb.

A. minutissima Sm. A.
A. ovalis Ktz. P., A., Newborough Warren.

Genus *Cocconeis* Ehrb.

C. Pediculus Ehrb. A.
C. Placentula Ehrb. A.
C. Thwaitesii Sm. Bettws-y-coed.

Genus *Achnanthes* Bory.

A. exilis Ktz. C.

Genus *Denticula* Ktz.

D. tenuis Ktz. C.

Genus *Odontidium* Ktz.

O. hiemale (Lyngb.) Ktz. C., Bettws-y-coed, Llanfairfechan.
O. mesodon Ktz. A.
O. mutabile Sm. A.

Genus *Fragilaria* (Lyngb.) Ag.

F. capucina Desmaz. Bodorgan, Moel Fammau.
F. virescens Ralfs. A.

Genus *Diatoma* DC.

D. vulgare Bory. Bodorgan.
D. grande Sm. Llyn Idwal.
D. elongatum Ag. Do., C., Llyn Idwal, Penmaenmawr, Llyn Ogwen.

Genus *Synedra* Ehrb.

S. lunaris Ehrb. C., F., Llyn Idwal.
S. biceps Ktz. D.
S. Smithii Pritch. (*S. acicularis* Sm.). Llandudno.
S. ulna Ehrb. A., C., Do., B., Llyn Idwal, Llanfairfechan.
S. splendens Ktz. (*S. radians* Sm.). Frequent.
S. obtusa Sm. A.
S. delicatissima Sm. A.
S. capitata Ehrb. D., A., Llyn Idwal, Holyhead.

Genus *Asterionella* Hass.

A. formosa Hass. A., C., Llyn Idwal.

Genus *Amphipleura* Ktz.

A. pellucida Ktz. A.

Genus *Nitzschia* Hass.

N. Amphioxys Sm. A., C.
N. vivax Sm. A.
N. constricta (Ktz.) Pritch. (*N. dubia* Sm.) A.
N. parvula Sm. C.
N. sigmoidea Sm. A., P., Llandudno, Bettws-y-coed, Llanfairfechan.
N. curvula (Ehrb.) Sm. C., P.
var. *subcapitata* (Hantzsch) Rabh. C.
N. linearis (Ag.) Sm. A., Bodorgan.
N. tenuis Sm. S., A., Holyhead.
N. minutissima Sm. A.

Genus *Nitzschiella* Rabenh.

N. acicularis (Sm.) Rabh. (*Nitzschia acicularis* Sm.). P.
N. gracilis (Bréb.) Rabh. (*Nitszschia tænia* Sm.). Llandudno.

This only occurred in this locality associated with *Lyngbya littoralis* (Carm.) in a pool not far from the sea.

Genus *Navicula* Bory.

N. cuspidata Ktz. Do., C.
N. rhomboides (Ehrb.) Greg. A., C., B., S., Llyn Idwal.
N. serians Ktz. C., P.
N. elliptica Ktz. (*N. ovalis* Sm.). A.
N. limosa Grun. C., A., Holyhead.
N. gibberula Sm. A.
N. obtusa Sm. (*N. hebes* Ralfs). A.
N. inflata Ktz. C., A., B.
N. Amphisbæna Bory. A.

N. sphærophora Ktz. A.
N. Semen Ehrb. A.
N. affinis Ehrb. C., Llandudno.
N. Amphirhyncus Ehrb. P., C., Do.
N. producta Sm. P., Do.
N. angustata Sm. C., B., Llandudno.
N. cryptocephala Ktz. D., P.
N. dicephala Ehrb. C., A.
N. binodis Ehrb. A.

Genus *Pinnularia* Ehrb.

P. nobilis Ehrb. C., S., Do.
P. major Sm. C., S., Do., Llyn Idwal, Penmaenmawr, Holyhead.
P. Rabenhorstii Ralfs (*P. interrupta* Rabh.). C.
P. Tabellaria Ehrb. var. *acrosphæria* Rabh. (*P. acrosphæria* Rabh.). C., Holyhead.
P. gibba Ehrb. A., Do., C.
P. lata Sm. A.
P. viridis (Ehrb.) Sm. Common.
P. alpina Sm. C., Twll Du.
P. radiosa (Ktz.) Rabh. A., Llyn Idwal, Bodorgan.
var. *angusta* (Grun.) Rabh. (*Navicula angusta* Grun.). A.
P. viridula (Ktz.) Rabh. C., Llyn Idwal, Holyhead.
P. acuta Sm. A.
P. mesolepta Sm. C., D., P.
P. divergens Sm. D., B., S., A.
P. Brebissonii (Ktz.) Rabh. (*P. stauroneiformis* Sm.). A., C., S., P.

Genus *Frustulia* (Ag.) Rabh.

F. saxonica Rabh. forma *aquatica* Rabh. (*Navicula crassinervia* Bréb.). C., S.

Genus *Pleurosigma* Smith.

P. attenuatum (Ktz.) Sm. A.
P. acuminatum (Ktz.) Grun. var. *lacustre* (Sm.) Rabh. (*P. lacustre* Sm.). Newborough Warren.

Genus *Stauroneis* Ehrb.

S. Phœnicenteron (Nitzsch) Ehrb. P., C., Do., Moel Fammau.
S. gracilis Sm. Do., C., P., Newborough Warren.
S. anceps, Ehrb. A.
S. dilatata Sm. A.

Genus *Pleurostaurum* Rabh.

P. Legumen (Ehrb.) Rabh. (*Stauroneis linearis* Sm.). C.

Genus *Gomphonema* Ag.

G. tenellum Ktz. Bettws-y-coed.
G. dichotomum Ktz. A., Bettws-y-coed.
G. capitatum Ehrb. A.
G. constrictum Ehrb. Do., S., A.
G. acuminatum Ehrb. D., C., A., Llyn Idwal.
G. intricatum Ktz. A.

Genus *Meridion* Ag.

M. circulare (Grev.) Ag. A., Llyn Ogwen.
M. constrictum Ralfs. Llandudno.

Genus *Tabellaria* Ehrb.

T. flocculosa (Roth.) Ktz. Common.
T. ventricosa Ktz. B., C., S., Do., Llyn Ogwen.
T. fenestrata (Lyngb.) Ktz. C., A., S., Llyn Idwal, Penmaenmawr.

Genus *Tetracyclus* Ralfs.

T. lacustris Ralfs. C.

This list, together with those records previously mentioned of Messrs. Cooke and Wills, enumerates 545 species and 45 varieties and forms.

Note by A. W. Bennett, F.L.S.

As Mr. West has been kind enough to send me his MS., together with some of his slides, perhaps I may be allowed to append the following notes. The neighbourhood of Capel Curig is certainly one of extraordinary richness, especially in Desmids, not only in species but in individuals; and Mr. West has worked it with great care and knowledge. Compared with the richest locality with which I am personally acquainted, Skelwith in Westmoreland, it is certainly considerably more productive. It may help to give an idea of the extent to which Mr. West's paper enlarges our knowledge of the geographical distribution of Desmids, if I append the following list of species found by him (in addition to those marked with an asterisk) which have no locality in Great Britain assigned to them in Dr. Cooke's work, although some of them have since been found in other spots by myself or other observers:—Gonatozygon Brebissonii, Sphærozosma pulchellum, Docidium coronatum, Closterium obtusum, prælongum, gracile, Cynthia, Kützingii, and subulatum, Penium spiro-striolatum and Mooreanum, Cylindrocystis diplospora, Spirotænia truncata, Micrasterias mucronata, Euastrum venustum, Cosmarium homalodermum, truncatellum, exiguum, Regnesii, orthostichum, quinarium, and hexalobum, Calocylindrus palangula, Xanthidium antilopeum, Arthrodesmus

tenuissimus, Staurastrum O'Mearii, oligocanthum, furcatum, Griffithsianum, pygmæum, lanceolatum, striolatum, capitulum, aversum, Ophiura, cerastes, and sexangulare.

Micrasterias furcata Ag. occurs in several of the gatherings from Capel Curig; both the typical form and one with longer arms.

Euastrum verrucosum Ehrb. The typical form occurs, as well as Joshua's var. *simplex*.

Euastrum Jenneri Arch. Capel Curig.

Cosmarium isthmium West. I very much doubt whether this can be maintained as a distinct species. It seems to me to agree with *C. orbiculatum* Ralfs in size as in other important points. The width of the isthmus is probably merely an indication of an early stage in the process of division.

Staurastrum brasiliense Lund. This rare and beautiful desmid occurs in several of Mr. West's slides.

Staurastrum Ophiura Lund. I can quite corroborate Mr. West's statement that all the specimens of this very rare and beautiful desmid observed from his gatherings are 8- or 9-rayed, the former being much the most common. It is somewhat singular that, although Dr. Cooke describes it as "7 (rarely 6 or 8) rayed," he figures it as 8-rayed. The papillæ in the centre I find to be numerous, scattered, and simple, not few, quadrifid, and arranged in a coronet; in fact, the Welsh specimens agree with both Cooke's and Wolle's figures better than with their descriptions.

Staurastrum cerastes Lund. In several slides from Capel Curig.

Staurastrum vestitum Ralfs. Capel Curig.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Weismann's Theory of Heredity.‡—There have been some complaints on this side of the Atlantic as to the manner in which a recent discussion on this subject has been conducted in the columns of 'Nature.' We have not, however, noticed there any sentences comparable to some used by Mr. J. A. Ryder, who urges that the Lamarckian philosophy of transformism offers a hypothesis of heredity as "a substitute for the preposterous one of the isolation of germ-plasma," which Mr. Ryder regards as "in the most obvious conflict with the principle of the conservation of energy. An isolated germ-plasma is as undemonstrable as the presence of bow-legged goblins in the moon. . . . Biologists who commit themselves to an acceptance of the biological vagaries of Weismann array themselves against the modern rigorously scientific tendency to examine the problem of biology from the standpoint of the physical." "A colossal fabric of speculative rubbish must be consigned to the limbo of untenable and forgotten hypotheses in what is represented by the misguided labours of the advocates of the existence an unalterable germ-plasma."

Human Embryo.§—Sig. G. Chiarugi describes the anatomy of a human embryo which measured only 2·6 mm. in length, and was apparently from three to four weeks old. The embryo was marked by a deep dorsal concavity, difficult to explain. There was a marked disproportion between the elongation of the spinal cord, notochord, and gut on the one hand, and that of the lateral parietes on the other. The

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Amer. Natural., xxiv. (1890) p. 92.

§ Atti Soc. Tosc. Sci. Nat., x. (1889) pp. 66-94 (2 pls.).

state of the different systems, and also of the amnion and umbilical cord, are described. Finally, the author notes the abundant occurrence of cells which, instead of definitely contoured nuclei, contained small, spherical, isolated granules.

Structure of the Placenta in Man and Monkeys.*—Prof. W. Waldeyer recurs to two previous communications on the structure of the placenta in *Homo* and in the catarrhine monkey *Inuus nemestrinus.* To his first question, whether the intervillous spaces normally contain maternal blood, he gives an emphatically affirmative answer. He passes to the relation of uterine blood-vessels to the placenta, distinguishing the arteries and veins. The third part of his paper deals with the epithelium of the villi and the lining of the intervillous and other spaces. Ten opinions about the epithelium and five in regard to spaces are chronicled, and the paper, which is in great part a historical critique, closes with a brief reference to the origin of the decidua and the relation of the placenta of *Inuus* to that of *Homo.*

Development of Platydactylus.†—Dr. L. Will has had the opportunity of studying the development of *Platydactylus mauritianus.* He finds that the process of gastrulation is much more primitive than in any Reptile hitherto examined, while the great extent of the archenteron allies it to Amphibia. The differences observed may be explained by the different relations of the yolk. A comparison of the Gecko-gastrula with that of Urodeles shows that the blastopore of Reptiles corresponds to the whole blastopore of Amphibia. It has hitherto been largely a matter of hypothesis to say that the primitive groove is formed by the lips of the blastopore, but the Gecko has proved the point. It can now also be shown that the cephalic process of the primitive stripe in other Amniota is nothing more than the solid archenteric invagination of the Gecko. In other points, the study of the development of the Gecko leads to the same general results as those to which Van Beneden has been lately brought by a study of the development of the Chiroptera.

Amphibian Blastopore.‡—Mr. T. H. Morgan has studied the embryos of *Bufo lentiginosus*, *Rana halecina*, and *Amblystoma punctatum.* In the last of these it seems that the blastopore was situated in the posterior part of the medullary groove, and partially surrounded by a continuation of its walls on each side; that it was then overarched in its anterior part by a continuation of the medullary folds; that, on account of its elongation, its posterior end escaped this closing over; and that by the shutting in of the medullary folds the digestive tract came to communicate with the neural tube by the anterior end of the blastopore, and with the exterior by the posterior end of the blastopore.

This Amphibian appears to present us with an idea of the changes which have in general taken place in the phylogeny of the blastopore. The author is forced to believe that the neurenteric canal is a rudimentary organ which at some time had an important function; it has remained partly stable in position, though the anus has wandered far from its original station. It is very probable that the neural tube once

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 1–51 (2 pls.).
† SB. K. Preuss. Akad. Wiss. Berlin, 1889, pp. 1121–8.
‡ Studies from Biol. Lab. John Hopkins Univ., iv. (1890) pp. 355–77 (3 pls.).

formed a water-tube, and in that of adult frogs the ciliated epithelium may still be seen to drive carmine-granules towards the tail.

Lepidosteus.*—Mr. E. L. Mark has had the opportunity of studying the development of *Lepidosteus*. He finds that both the egg-membranes are radially striated, and he corrects some observations of Balfour and Parker. The villi of one membrane are each composed of three parts —head, stalk, and roots; the last of these project into the pore-canals of the zona. The single micropyle of the egg has been overlooked by previous observers; the micropylar apparatus embraces a funnel and a canal; the former results from an infolding and a reduction in thickness of both the villous layer and the zona radiata.

The granulosa of the mature ovarian egg consists of a single layer of polygonal cells, except in the region of the funnel, where it forms a plug of cells that completely fills the funnel. A single large granulosa cell forms the apex of the plug, and occupies the bottom of the funnel.

An egg-membrane comparable structurally and genetically with the zona radiata of bony fishes is to be found in representatives of all the groups of fishes; it is fugitive in Selachians and *Lepidosiren*, and probably in viviparous Teleosteans. The zona is produced by the ovum, not by the follicular cells, and is traversed in all cases by pore-canals, which rarely branch. An egg-membrane, genetically but not always structurally, comparable with the villous layer of *Lepidosteus*, is found in several other cases; it, also, is produced by the ovum, and earlier than the zona.

As to the function and history of the micropylar apparatus, the author suggests that the micropyle, being evidently a provision for the fertilization of the ovum, may owe its present structure to two tendencies which to some extent conflicted; one was induced by the advantages of protection to the egg, the other by the necessity of some provision for the penetration of the fertilizing element. An optimum condition is reached when the penetrable area is reduced to a minimum, and that is the diameter of the head of a spermatozoon. The funnel may be a partial compensation for such reduction. The micropylar plug may mechanically determine the presence and form of a funnel. The micropylar cell may serve to form the canal by resorption, or to prevent the occlusion of the canal by less penetrable matter at the time of oviposition.

Structure of Spermatozoa.†—Prof. G. A. Piersol discusses the structure of spermatozoa, and especially those of *Amphiuma tridactylum*. In those of that Batrachian the tail presents the most interesting modifications. Starting with a sharply-cut transverse edge with a width of about 0·001 mm., it extends as a blade-like appendage to a length of 0·2 mm., increasing to a width of 0·0018 mm. or more at the broadest part. The lower margin of the blade is formed by a relatively thick chief axial-fibre, while along the upper edge there is a secondary, thinner and shorter, fibre. When these fibres separate they are united by an extremely delicate but rigid membrane, which is perfectly smooth. Along the entire lower border of the chief fibre a beautiful gill-like membrane is attached, "the graceful folds of whose free edge form a

* Bull. Mus. Comp. Zool., xix. (1890) pp. 1–127 (9 pls.).
† University Medic. Mag. Philadelphia, 1889, 20 pp. (sep. copy), 1 pl.

picture in elegance unequalled by the similar membranes of any of the newts."

The author is of opinion that ripe mammalian spermatozoa are devoid of recognizable structure, and that the numerous and complicated peculiarities which have been described belong to developing elements.

β. Histology.*

Cell-Theory, Past and Present.†—Prof. Sir W. Turner took the cell-theory, past and present, as the subject of his inaugural address to the Scottish Microscopical Society; while Protoplasm and the Cell-Doctrine was the subject of Mr. C. F. Cox's ‡ annual address to the New York Microscopical Society.

Influence of Nucleus on Protoplasm.§—Dr. B. Hofer has made a number of experiments on the influence of the nucleus on protoplasm. His results may be shortly summarized thus:—

The cell-nucleus has a direct influence on: (*a*) the movement of protoplasm, in which, indeed, the capacity for movement dwells, though it can only be developed in its characteristic forms by its relations to the nucleus; in other words, the nucleus is a regulating centre for movement; (*b*) digestion in so far as a secretion of digestive juices is only possible when nucleus and protoplasm work together.

The cell-nucleus has no direct influence on the respiration of protoplasm or the function of the contractile vacuole.

Biology of the Cell.‖—Sig. E. Verson calls attention to the regular changes undergone by the cells of a special mass in the larva of the silk-worm. These cells lie below the stigmata, on the fourth to the eleventh rings of the body, between the musculature and hypodermis; they are arranged in groups of twenty-five to forty, and may correspond to the so-called œnocytes of Wielowiejski. As soon as the process of ecdysis begins, the nucleus of these cells loses its rounded form and becomes constricted at points; it diminishes considerably in size, and clear vacuoles filled with fluid appear around it in the protoplasm; these vacuoles get nearer and nearer to the periphery, and finally open to the exterior. The lumen of the nucleus shrivels up to a narrow cleft. Various other changes, best seen in specimens stained with ammoniacal carmine, are effected, but at last the nucleus is reconstituted, and the whole cycle recommences.

Phagocytes of Alimentary Canal.¶—Dr. A. Ruffer finds that the wandering cells of the lymphoid tissues of the alimentary canal have the power of proceeding to the free surface of such tissues, and of taking into their interior lower micro-organisms and foreign matter such as charcoal. These wandering cells may be either small and mono- or polynucleated cells (microphages), or large mono-nucleated cells (macrophages); the latter are developed from the small mono-nucleated

* This section is limited to papers relating to Cells and Fibres.

† Edinburgh, 1890, 44 pp.

‡ Journal New York Micr. Soc., vi. (1890) pp. 17–44.

§ Jenaische Zeitschr. f. Naturw., xxiv. (1889) pp. 105–76 (2 pls.).

‖ Zool. Anzeig., xiii. (1890) pp. 91–2.

¶ Quart. Journ. Micr. Sci., xxx. (1890) pp. 481–505 (1 pl.).

lymphocytes, and are able to swallow the former (leucocytes), and to destroy and digest them. Within the interior of both, micro-organisms are rapidly destroyed, and these last are never found living free between the cells or in the blood-vessels and lymphatics. The destruction of micro-organisms in the normal lymphoid tissues of the alimentary tract resembles in all particulars the destructive process which follows the inoculation of pathogenic organisms into resistent animals.

Histology of Striped Muscle.* — Mr. C. F. Marshall gives an account of his further † observations on the histology of striped muscle. He finds that the transverse portions of the network of the striped muscle-fibre are directly connected with the muscle-corpuscles. The nerve-ending appears to be connected with the muscle-network, and chiefly with its longitudinal bars. The development of the network takes place at a very early stage in the development of the fibre and is, from the first, developed in its permanent form. It developes first at the surface and grows centripetally, and it does not appear to be connected with the muscle-corpuscles till the fibre is fully developed. Each muscle-fibre appears to be developed from a single cell, and not by a coalescence of cells. *Dytiscus*, the Dragon-fly, and the Crayfish were used for investigation, while the development of the network was studied in embryos of the trout and rat.

γ. General.

Classification of the Metazoa.‡—Prof. E. Haeckel, at the conclusion of his report on the Deep-sea Keratosa, gives a synopsis of the Metazoa which differs somewhat from most of the classifications in vogue in this country.

A. First Main Branch.

CŒLENTERIA.

Phylum I. GASTRÆADA.

Classes: 1. Physemaria; 2. Cyemaria (Orthonectidæ, Dicyemidæ).

Phylum II. SPONGIÆ (PORIFERA).

Classes: 1. Malthospongiæ; 2. Silicispongiæ; 3. Calcispongiæ; or, perhaps, better: 1. Protospongiæ (Tubulosæ); 2. Metaspongiæ (Vesiculosæ).

Phylum III. CNIDARIA (ACALEPHÆ).

III. *a*. Subphylum 1. HYDROZOA.

Classes: 1. Hydropolypi; 2. Hydromedusæ; 3. Siphonophora.

III. *b*. Subphylum 2. SCYPHOZOA.

Classes: 4. Scyphopolypi; 5. Anthozoa; 6. Scyphomedusæ.

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 65-82 (1 pl.).

† See this Journal, 1887, p. 935.

‡ Reports of the Voyage of H.M.S. 'Challenger,' xxxi., Part lxxxii. (1889) pp. 90-2.

Phylum IV. PLATODA.

Classes: 1. Turbellaria; 2. Trematoda: 3. Cestoda; 4. Ctenophora (?).

B. Second Main Branch.

CŒLOMARIA (CŒLOMATA vel BILATERIA).

Phylum V. Helminthes (Vermes).

V. *a*. Subphylum 1. ARCHELMINTHES.

Classes: 1. Trochozoa; 2. Rotatoria.

V. *b*. Subphylum 2. STRONGYLARIA.

Classes: 3. Nematoda; 4. Acanthocephala; 5. Chætognathi.

V. *c*. Subphylum 3. RHYNCHOCŒLA.

Classes: 6. Nemertinea; 7. Enteropneusta.

V. *d*. Subphylum 4. PROSOPYGIA.

Classes: 8. Bryozoa; 9. Phoronida; 10. Brachiopoda.

Phylum VI. MOLLUSCA.

VI. *a*. Subphylum 1. COCHLIDES.

Classes: 1. Placophora; 2. Gastropoda; 3. Scaphopoda; 4. Pteropoda.

VI. *b*. Subphylum 2. CONCHADES.

Class 5. Acephala.

VI. *c*. Subphylum 3. TEUTHODES.

Class 6. Cephalopoda.

Phylum VII. ECHINODERMA.

VII. *a*. Subphylum 1. THECOSTELLÆ.

Classes: 1. Holothuriæ; 2. Echinida.

VII. *b*. Subphylum 2. PECTOSTELLÆ.

Classes: 3. Cystidea; 4. Crinoidea; 5. Blastoidea.

VII. *c*. Subphylum 3. ANTHOSTELLÆ.

Classes: 6. Ophiuræ; 7. Asterida.

Phylum VIII. ARTICULATA.

VIII. *a*. Subphylum 1. ANNELIDA.

Classes: 1. Hirudinea; 2. Chætopoda; 3. Gephyrea; 4. Myzostomida.

VIII. *b*. Subphylum 2. CRUSTACEA.

Classes: 4. Caridonia (Carides); 5. Aspidonia (Merostomata).

VIII. *c*. Subphylum 3. TRACHEATA.

Classes: 6. Onychophora; 7. Myriapoda; 8. Arachnida; 9. Insecta.

Phylum IX. Chordonia.

IX. *a.* Subphylum 1. Tunicata.

Classes: 1. Copelata; 2. Ascidiæ; 3. Thaliæ.

IX. *b.* Subphylum 2. Vertebrata.

Classes: 1. Acrania; 2. Cyclostoma; 3. Pisces; 4. Dipneusta; 5. Amphibia; 6. Reptilia; 7. Aves; 8. Mammalia.

Sensitiveness and Adaptability of Organisms to Saline Solutions.*—Dr. J. Massart finds that the organic excitation produced by saline and other solutions varies according to the molecular weight and molecular structure of the substance. The repulsion, studied with most precision in Bacteria, is inversely proportional to the molecular weight, and directly proportional to the "isotonic coefficient," or the attraction of the substance for water. The unity chosen in estimating this last factor is a third of the attraction exercised on water by a molecule of nitrate of potassium. Massart experimented not only on Bacteria, but on Infusorians, *Hydra*, the skin of the frog, and the conjunctiva of man. The latter is sensitive, not only to solutions more concentrated than tears, but also to others less so; it may be anæsthetized as regards pain and touch, while remaining quite sensitive to degrees of concentration. He gives numerous illustrations of adaptability of Bacteria, Infusorians, &c., to concentrated solutions, the adaptation being due to a permeation of the protoplasm by the dissolved substance. An appendix contains many interesting facts in regard to the comparative sensitiveness of small organisms. A method is suggested by which this variable sensitiveness might be taken advantage of to secure the isolation of desired specimens and the elimination of others.

Natural History of Victoria.†—Prof. F. M'Coy has issued part 19 of the Prodromus; three plates are devoted to Bryozoa, and three to the large Melbourne Cuttle-fish (*Sepia apama* Gray).

B. INVERTEBRATA.

Marine and Freshwater Invertebrate Fauna of Port Jackson and Neighbourhood.‡—Mr. T. Whitelegge has published a list of the invertebrates found in fresh or salt water at or near Port Jackson. This will be very useful in the colony, and is instructive to zoologists generally. A good deal has still to be done before anything like a complete census of this fauna can be attempted. Attention is drawn to one starfish which offers peculiar opportunities to the embryologist; it inhabits the zone between high and low water mark; the eggs are deposited under stones in little rock-pools, and the young, when hatched out, never leave the spot until they assume the form of the adult.

Mollusca.

American Mollusca.§—Mr. W. H. Dall has published a preliminary catalogue of the shell-bearing Marine Molluscs and Brachiopods of the

* Arch. de Biol., ix. (1889) pp. 515–70.
† 'Prodromus of the Zoology of Victoria,' xix. (1889) pp. 297–327 (pls. 181–90).
‡ Sydney and London, n. d. [read 3rd July, 1889], 8vo, 161 pp.
§ Bull. U.S. Nat. Mus., No. 37 (1889) 221 pp. (74 pls.).

south-eastern coast of the United States, to which are added illustrations of many of the species. The systematic conchologist will be glad to have this work.

β. Pteropoda.

Cymbuliopsis Calceola.*—Mr. J. I. Peck gives an account of the anatomy and histology of this Pteropod, serial sections of which were made. The tentacles are, at best, mere knob-like structures with rudimentary sensory apparatus at their base. All the tissues of the animal are exceedingly translucent, so that the course of the œsophagus may be followed from a surface view. The visceral nucleus is dark brown and rounded, and contains the digestive and reproductive organs, while on its dorsal surface are laid the heart and nephridium. The primitive molluscan foot cannot be recognized in the adult, but its successor, the fin, has attained a very large size, and is moved by muscles which are laid in regular intercrossing bands a little beneath the epithelial surface of either side; the thickness of the fin is due to the branching network of connective-tissue cells which is so characteristic of molluscan histology. The pallial cavity is on the ventral side, and is made by the large fold of the mantle which extends from the dorsal part of the animal beneath the fin, thickening between its two epithelial layers into the hyaline "casque." Part of the inner layer of the mantle is specialized into the pallial gland or "shield" of thecosomatous pteropods. The genus seems to be typical of the family to which it belongs.

γ. Gastropoda.

Anatomy and Histology of Renal Organs of Prosobranch Gastropods.†—M. R. Perrier has an extended memoir on this subject. The urinary apparatus of Prosobranchs primitively consists of two symmetrical organs identical in structure and function; each consists of a sac, which communicates on the one hand with the pericardium, and on the other with the exterior. Absolute symmetry, however, is never seen in them. In the Diotocardia (with the exception of the Neritidæ) and in the Heterocardia the organ of one side never communicates with that of the other; their orifices, which are also always distinct, are situated at the tips of papillæ which project into the mantle-cavity. *Fissurella* is the only Prosobranch which retains any of the primitive symmetry; but the left organ is much reduced, and does not communicate with the pericardium. The two kidneys have the same function. In all the rest the right kidney is the true renal organ, while the left, which is remarkable for its plasticity, always undergoes modifications in position or constitution. In *Patella* the two kidneys have renal functions, but the left, which is quite small, lies between the pericardium and the right kidney, and it appears to have lost its communication with the pericardium.

In the Heteronephridiata (*Haliotis*, Trochidæ) the left kidney undergoes a complete change, being converted into the papillary sac. It seems to have become an important reserve-organ, which communicates

* Stud. Biol. Lab. John Hopkins Univ., iv. (1890) pp. 335–53 (2 pls.).
† Ann. Sci. Nat, viii. (1889) pp. 61–315 (9 pls.).

only with the pericardium; the right organ, which has alone the depuratory function, has lost this communication. This right kidney is placed in the course of the blood which comes from the lacunæ of the body to pass to the gills. In *Haliotis* all the blood traverses it; in the Trochidæ part only; in the Monotocardia it receives but a small part of the blood, and a special vascular area is formed for it with afferent and efferent passages which are independent of the general circulation. The left kidney of the Diotocardia, as well as that of *Patella* and the Heteronephridiata, has a vascular system directly connected with the auricle or auricles. The Neritidæ have only one kidney.

The Monotocardia have a single renal cavity and a single excretory orifice. The latter is simple and is placed at the base of the pallial chamber. To this rule *Valvata* and *Paludina* alone form exceptions; they have an excretory canal which opens by an orifice placed at the anterior edge of the mantle. The kidney is not a large gland, nor is it acinous. Its secreting epithelium is arranged on lamellæ or trabeculæ which form a spongy mass; the lamellæ are attached to the lateral walls and the urinary cavity is free in the centre. In freshwater Prosobranchs (*Neritina*, *Paludina*) the glandular mass is, as a rule, considerably developed. It fills the urinary cavity, and the kidney has then the appearance of a large spongy body; *Cyclostoma* and *Valvata* are exceptions to this rule.

The glandular mass, that is to say the active part of the kidney, is divided into two glands which are quite distinct—the kidney properly so called, and the nephridial gland. The latter has almost always the form of a band which extends along the pericardium, and sometimes also along the base of the branchial cavity. Its colour is different from that of the kidney. It is hollowed out by a lacuna which is bounded, especially on the side nearer the urinary cavity, by a layer of powerful muscles, the function of which is to regulate the circulation in the organ. This lacuna is a diverticulum of the auricle, with which it freely communicates; it is partially obliterated by connective tissue, the essential elements of which are large cells; these are arranged in the meshes of a plexus of stellate connective cells. The function of this gland is to modify the constitution of the blood either by pouring into it definite products or formed elements. It is, therefore, an organ of reserve or lymphatic gland. On the side near the renal cavity the nephridial gland is lined by an epithelium which projects into its interior, where there are branched canals which are always well separated from the blood-lacuna. The nephridial gland may be considered as representing the left kidney of the Diotocardia. *Patella* is an intermediate form.

In most of the Tænioglossata the glandular mass of the true kidney is homogeneous in structure, but in a few (*Natica*, *Cypræa*) there are signs of differentiation. The Stenoglossata have the organ divided into two lobes, and further modifications and differentiations may be traced.

There are two types of renal gland-cells; that of the first is to be seen in the Diotocardia. They are very generally ciliated; sometimes they contain no foreign concretions, but at others the bodies excreted by the cell condense in the form of small concretions, of which there are

often a number. The renal gland-cells of the Monotocardia, on the other hand, do not produce a diffused concretion. The excreted liquids become concentrated into one place so as to form a spherical vacuole, which is placed near the periphery of the cell. This vacuole increases in size, and the salts contained in suspension in the liquid which forms it condense into a large concretion or, sometimes, into several smaller masses. The cells are not, as a rule, ciliated, but the presence or absence of cilia is a secondary matter.

The mechanism of the urinary secretion varies as the secretion is diffuse or vacuolar; in the former case it seems to be merely effected by osmosis, but in the latter the vacuole escapes from the cell and falls into the renal cavity surrounded by a delicate protoplasmic envelope. The cell is reformed after the expulsion of the vacuole, and continues to exercise its function.

M. Perrier applies the results he has obtained to a classification of the Prosobranch Gastropods, and, in an appendix, he institutes a comparison between the renal organ of these and that of other Molluscs. He is led by it to agree with de Meuron in comparing the larva of a Mollusc with that of an Annelid, with this difference, that in place of a chain of a number of somites there are in the Mollusca only two.

Blood and Lymph-gland of Aplysiæ.*—M. L. Cuénot finds that the blood in the heart of the Atlantic *Aplysia depilans* is distinctly rosy. This coloration is due to the presence of an albuminoid, and has no relation to the absorption of oxygen. The albuminoid, which is distinct from hæmocyanin, may be called hæmorhodin. The blood of the Mediterranean *A. punctata* is quite different, for it contains colourless hæmocyanin. The amœbocytes appear to be formed by the crista aortæ. This is a large hollow dilatation of the anterior aorta which has something of a glandular appearance; it is inclosed with the heart in the pericardium. When an injection is forced in, it swells up like an erectile organ, but returns to its normal dimensions when the pressure ceases. Its wall is formed by a thick felting of connective tissue and of elastic fibres which anastomose and divide in all directions. Among these are masses of nuclei, a large number of which are surrounded by protoplasm; these are evidently mature amœbocytes which are ready to pass into the blood. Somewhat similar structures have been observed in *Philine* and *Scaphander*.

Pleurophyllidiidæ.†—Dr. R. Bergh gives a systematic review of this group; in the forms newly examined by him he observed that the buccal armature varies in the different species in a way never noticed in any other group of Nudibranchs.

Structure and Functions of Cerata in some Nudibranchiate Molluscs.‡—Prof. Herdman here enters into some greater details as to the structure and functions of the cerata of Molluscs, than in the report we noticed some months since.§ Full illustrations are now given.

* Comptes Rendus, cx. (1890) pp. 724–5.
† Abh. Zool.-Bot. Gesell. Wien, 1889, pp. 1–14 (2 pls.).
‡ Quart. Journ. Micr. Sci., xxxi. (1890) pp. 41–63 (5 pls.). See also Rep. Brit. Assoc., 1889 (1890) pp. 630–3.
§ See this Journal, 1889, p. 627.

Organization of Sinistral Prosobranchiate Gastropoda.*—MM. P. Fischer and E. L. Bouvier have examined some of these "left-handed" Molluscs. In *Neptunea contraria* it was found that all the organs which are placed on the right in dextral Prosobranchs are on the left, and *vice versâ*; correlated modifications were observed in the organization of the animal, in, for example, the ganglia and the nerve-branches.

Molluscoida.

β. Bryozoa.

Bryozoa of Japan.†—Dr. A. Ortmann has a paper on the Bryozoa collected by Dr. L. Döderlein in Japan, a region from which only three species were previously known. Of the 137 species reported on, 85 are said to be new, and three of these require new genera to be established for their reception.

Asexual Multiplication of Endoproctal Polyzoa.‡—Dr. O. Seeliger has investigated the formation of the Polyzoon stock, the budding at the free end of the main stolon, the branching of the stolon, the formation of new buds between the old, and finally the regeneration of the polype head. His general conclusions may be summed up as follows:—As in other classes, the budding process is condensed in contrast with the ordinary development. In *Loxosoma* the buds go free; in *Pedicellina* they are fixed and become mature at their points of origin; in all cases they grow without metamorphosis, and exhibit none of the provisional larval structures. In the bud there is no process comparable to segmentation, for it starts as a two-layered rudiment, with epithelial ectoderm and with mesenchyme, but with the development of the inner layer much belated. In every forming bud, the "polypide" originates from a fresh invagination of ectoderm, which is probably, to begin with, referable to a single cell. If this fact be connected with Nitsche's observation that the mesenchyme in *Loxosoma* was derived from the ectoderm, then O. Schmidt's paradox about the buds of *Loxosoma* becomes intelligible—that the process is not a budding, but the direct development of an ovum which has passed into the ectoderm, and there starts the apparent bud. Neither Nitsche's observation nor Schmidt's conclusion is, however, to be accepted. According to Seeliger, the budding is a process of gastrulations repeated by the ectoderm on various regions of the adult animal or of its stolon.

At the apex of the stolon, where large ectodermic cells lie, an evagination occurs which begins a bud. At the apex of this, the ectoderm is invaginated to form the "polypide." A few mesoderm cells of the stolon have wandered into the cavity of the bud, where they multiply so rapidly as to fill the space. The polypide invagination is divided into two regions, an upper one which never loses its connection with the ectoderm layer, and a lower one which remains connected with the latter by a narrowing aperture which becomes the mouth. The upper part represents the atrium, and from it the tentacles arise with immigrant mesenchyme cells. By an evagination of the atrial wall the ganglion is

* Comptes Rendus, cx. (1890) pp. 412–4.
† Arch. f. Naturg., lvi. (1890) pp. 1–74 (4 pls.).
‡ Zeitschr. f. Wiss. Zool., xlix. (1889) pp. 168–208 (2 pls., 6 figs.).

formed, which soon frees itself and developes fibrillar substance in its centre. The lower part becomes the stomach and mid-gut. How far the hind-gut arises from another evagination of the atrium is undetermined. The mesoderm elements become connective-tissue and muscle-cells, and also form the gonads, whose paired rudiments lie laterally to the large ganglion. The process is thus comparable to gastrulation, for the mother animal supplies no endodermic rudiment. In this last respect the budding of Polyzoa differs markedly from that of Cœlenterata or Tunicata, where the endoderm plays an important part.

Arthropoda.

Morphology of Compound Eyes of Arthropods.*—Mr. S. Watase describes the structure of the ommatidium in *Serolis*, *Talorchestia*, *Cambarus*, *Homarus*, and *Callinectes;* describes the compound eye of *Limulus*,† and discusses the phylogeny of the ommatidium. He comes to the conclusion that the structure of the ommatidium of the compound eye of *Serolis* shows that it may be reduced to a simple ectodermic invagination of the skin. The same interpretation may be applied to the other Crustacea mentioned, and finds a strong support in the fact that, in *Limulus*, the ommatidium is an open pit of the skin.

By supposing that the ommatidial pit of *Limulus* became deeper, and that this increase in depth was accompanied by modifications in the structure and arrangement of the component cells, it becomes probable that the ommatidium of the compound eye of an Arthropod is an independent invagination of the skin. If this be so, the unit of the compound eye is not so complex a structure as some have supposed, and the enormous increase in the number of the ommatidia is merely an example of the well-known phenomenon of the duplication of a single unit.

α. Insecta.

Early Stages in Development of Ova of Insects.‡—Dr. H. Henking commences a series of memoirs with an account of the ovum of *Pieris brassicæ*, with remarks on the sperm and spermatogenesis. It is, however, unnecessary to give the details as the results attained are very much those already given for *Musca vomitoria* by the author and by Blochmann.§

Abdominal Appendages in Hexapoda.‖—Herr E. Haase urges that the researches of various observers commencing with Kowalevsky in 1871, justify the supposition that the existing Hexapoda are to be derived from polypodous myriopodiform ancestors. He brings together the observations made by various authors on abdominal appendages in a way which will probably be found very useful.

Composition of Body of Blattidæ.¶—The same author has made an investigation into the composition of the body of the cockroach and its allies. He recognizes in the mature embryo a frontal piece which bears

* Stud. Biol. Lab. John Hopkins Univ., iv. (1890) pp. 287-334 (7 pls.).
† For a preliminary note, see this Journal, 1889, p. 747.
‡ Zeitschr. f. Wiss. Zool., xlix. (1889) [1890] pp. 503-64 (3 pls.).
§ See this Journal, 1887, p. 743; 1888, p. 573.
‖ SB. Ges. Naturf. Freunde, 1889, pp. 19-29. ¶ T. c., pp. 128-36.

the labrum as a central process, and has as lateral appendages the antennary lobes, while it is perforated posteriorly by the orifice of the mouth. The original ventral position of the antennæ has often served as an argument in favour of their being limbs, but they must not be considered as equivalent to the persistent ventral appendages. Behind the frontal piece is the definite number of true metameres; the first three of these have their appendages converted into gnathites, and the head is thus formed; then follow the three thoracic segments with their legs, and then the abdomen, made up of ten true metameres, the appendages of which disappear at an early stage. Behind these comes the "anal piece" into which neither ventral cord nor secondary body-cavity are continued, and which has a remarkable resemblance to the frontal piece. For, like it, it has two terminal appendages, ventrally placed, which later on become the cerci as they move nearer to the anus. On the anal piece there is a median dorsal lamina supra-analis, and generally two anal valves; to these in rare cases a lower opercular piece is also added.

A method of notation is suggested whereby the presence or absence of the several metameres may be indicated, and the varying characters presented by various Insects seen at a glance.

The author is of opinion that the facts which he here brings forward afford a fresh proof of the relationship of the Cockroaches with the Thysanura; while they also show that the ventral plates of the Hexapoda do not correspond to the sternal shields of the same, and as little to the ventral shields of the Chilopoda, but that they owe their origin to the fusion of abdominal leg-rudiments, flattened out into plates, with an unpaired median shield.

Embryology of Blatta germanica.*—Mr. N. Cholodkovsky has a preliminary notice of the results of his studies in the development of *Blatta germanica*. The body-cavity arises within the rudiments of the extremities, which are hollow from the beginning, and gradually becomes shut off from the nutrient yolk; eighteen pairs of hollow somites are thus formed. During the formation of the endoderm the cavity of the somites divides, as in *Peripatus*, into three portions, one of which is, in all probability, homologous with the segmental infundibulum of *Peripatus*. In the later stages of development this division disappears. The permanent body-cavity is of mixed origin, for it contains remains of the primitive somite-cavity, schizocœl-spaces, and remains of the primitive cleavage-cavity. The heart is formed in the manner described by Schimkewitsch, and its cavity is a derivative of the primitive cleavage-cavity. The fat-body and the sexual cells arise from the yolk-cells, which in certain stages of development wander into the body-cavity.

Transformations of North American Lepidoptera.†—Mr. H. Edwards has published what ought to be a very useful bibliographical catalogue of the described transformations of North American Lepidoptera. Of some groups, such as the Noctuidæ, very little is yet known, but the subject is one of great interest and importance.

* Zool. Anzeig., xiii. (1890) pp. 137–8.
† Bull. U.S. Nat. Mus., No. 35 (1889) 147 pp.

Wing of Lepidoptera and its "Imaginal Disc."*—Sig. E. Verson refers to the general belief that the larvæ of Lepidoptera have no stigmata on the meso- and metathorax. Such an organ is, however, present, and is formed by a circlet of high hypodermal cells radially arranged around a common centre. The branch sent from the longitudinal tracheal trunk to the dorsal side of the stigmata of the second and third thoracic rings is long but delicate; its peritoneum is widened out into several berry-like saccules filled with cell-elements. In profile these rudimentary stigmates appear as a series of high hypodermal cells, which form the basis of a short blind tube. After the second ecdysis a special change occurs in these rudimentary organs. The tracheal branch connected with them sends off at various points thick tufts of capillary air-vessels, which press against the base of the cæcum. Gradually increasing in length they form a fold which continues to increase in length. The numerous tufts of tracheal capillaries extend beyond the inner surface of the two layers of which the developing wing consist; the berry-like saccules are drawn into the wing and converted into more or less thick tubes, which will form the "veins." It is clear, therefore, that the wings of Lepidoptera must be regarded as, in the fullest sense, organs of respiration.

System of Integumentary Glands of Bombycidæ.†—Signor E. Verson gives an account of the glands he has, after much trouble, been able to make out in the larva of *Bombyx mori*. There are two upper and two lower prothoracic glands, and similarly disposed meso- and metathoracic glands. The first to the eighth (inclusive) abdominal rings have two such glands, and in the eighth ring there is also a second pair. These glands, which can be made out in the embryo, persist during the whole of the larval period, constantly increasing in size; they are unicellular and function periodically. The author gives a short account of the changes which these glands undergo, and promises details and figures.

Colour and Veins of Butterfly Wings.‡—Dr. J. F. van Bemmelen has studied the development of the wings in *Pyrameis cardui*, *Vanessa urticæ*, and *Pieris brassicæ*, in order to discover how far the ontogeny of the colouring and venation sheds light on the phylogeny. The colours do not appear suddenly, but on the minute rudiments of wings. The colouring of the unravelled pupal wings is, however, very different from that in the imaginal state, though with some characters in common. The imaginal pattern is compounded from traces of more primitive types, both as regards pigmentation and veins.

Rectal Glands in Coleoptera.§—Prof. H. T. Fernald has found in the alimentary canal of *Passalus cornutus* a structure which he considers homologous with the rectal glands of other groups of insects. He describes the details of these organs, and gives reasons for regarding them as having a valvular function. This view is based on the facts that, (1) They are the best developed and most alike in Insects which feed on solid and quite innutritious food; in those forms with more

* Zool. Anzeig., xiii. (1890) pp. 116–7. † T. c., pp. 118–20.
‡ Tijdschr. Nederl. Dierk. Ver., ii. (1889) pp. 235–47.
§ Amer. Natural., xxiv. (1890) pp. 100–1.

concentrated or liquid food they vary greatly, and may even be wanting. (2) The valvular function would best explain the thick spiny chitinous lining and the remarkable development of the muscles. (3) Their position is also explained by this assumption, for a valve between the colon and rectum would serve to retain the food in the absorptive portions of the digestive tract till all nutriment was extracted, and then the combined action of the spines and muscles would pass the remainder on.

If these views are correct, we find the primitive valvular functions of the rectal glands in those insects which have retained their primitive food-habits, while they become vestigial, or are converted to other purposes in the more highly differentiated forms.

On Secreting Organs and Secretion of Wax in Bees.*—M. G. Carlet attempts a more definite account than has yet been given of the secretory apparatus and the secretion of wax in the bee. He comes to the conclusion that the wax is produced by the four last ventral arches of the abdomen; it is not secreted, as has been supposed, by the cuticular layer of these arches or by intra-abdominal glands, but by the cells of an epithelial membrane which he calls the waxy membrane (*membrane cirière*). This membrane is situated between two layers, the outer of which is cuticular, while the inner forms the internal investment of the anterolateral part of the ventral arch. The waxy substance traverses the cuticular layer and accumulates against its outer face, where it forms a layer of wax, which is covered by the ventral arch in front. Hitherto this passage of wax has been supposed; it has now been demonstrated.

Ecdysis and Metamorphosis of Acrididæ.†—M. J. Kunckel d'Herculais states that the egg-case of young Acrididæ is closed by an operculum admirably adapted for its purpose; this lid is raised by means of a cervical ampulla, and the same organ is of use in enabling these insects to overturn any obstacles which prevent their emergence. Moreover, it enables them to modify at will the various regions of their body, and so to escape through very small orifices. Yet, again, it is by means of this ampulla that they burst the envelope which incloses them. Freed from this, the young Acrididæ are able to make use of their limbs, and have the use of their antennæ and mouth-organs. At each successive ecdysis the membrane which unites the head and the thorax is capable of distension and of acting as a cervical ampulla; this distension is effected by the region becoming gorged with blood. The ampulla in question may, therefore, be compared to the frontal ampulla of the Muscidæ, but it has more extensive uses as it is of service when the young is still inclosed in the egg.

In a succeeding paper ‡ the author discusses the function of air in the mechanism of escape from the egg-case, and in the ecdysis and metamorphosis of the Acrididæ. He finds that, at all stages of development, these insects diminish the capacity of their general cavity by swallowing air into the digestive tract; by this means the air is driven into the cervical ampulla or into various regions of the body, and especially the elytra and wings.

* Comptes Rendus, cx. (1890) pp. 361–3. † T. c., pp. 657–9. ‡ T. c., pp. 807–9.

Biology of Chermes.*—Dr. K. Eckstein continues to write on this interesting subject; the details of the synonymy of the various species are now somewhat matter for specialists. We have on several occasions already indicated the methods of observation.†

Embryonic Development of Chalicodoma muraria.‡—Herr J. Carrière gives a brief account of the results of his investigations into the embryonic development of this Insect. The mesodermal plate, which is bounded by two grooves which converge anteriorly, consists of several layers before the period of invagination, and is not rolled into a tube as the result of this process. Shortly after the growth of the plate at its anterior end the anterior ectodermal rudiment appears in front of it and the folds in the blastoderm; later on no corresponding rudiment is seen. In both regions there is cell-growth, and, as a result, the uppermost blastoderm-layer becomes the ectoderm, and the rudiment of the endoderm is set free. From the beginning to the end of development the cells that form the endoderm and its derivatives differ both in size and appearance from those of the mesoderm and its derivatives.

The labrum consists of two independent folds which rise up on either side of the median line; they come together slowly. Each segment of the three pairs of gnathites and of the thorax, as well as the first eight segments of the abdomen, have a rudiment of a stigma, but only those of the meso- and metathorax and of the abdomen pass into the permanent stigmata. That of the anterior gnathite-bearing segment gives rise to the anterior tentorial rudiment, those of the median to the chitinous bar of the flexor mandibuli, and those of the hinder to the rudiment of the posterior tentorium. The salivary glands are derived from the rudiments of the stigma of the prothoracic segment. The first structure formed from the permanent stigmata is not the long tracheal trunk, but a short tube which ends blindly at the anterior boundary of the segment. This body calls to mind, in a very striking way, the structure of nephridia, and, indeed, the stigmata are the only organs of the Insect-body which can be compared to the efferent ducts of segmental excretory organs. The Malpighian vessels appear in the eleventh segment, but it is uncertain whether they are homologous with the rudiments of stigmata. The rudiments of the thoracic feet appear with those of the stigmata, and disappear when the embryo assumes the larval form; those of the abdominal somites do not appear till after them, and persist for a short time only.

Myrmecophilous Oak-galls.§—On the authority of Dr. H. C. M'Cook ('The Honey-ants of the Garden of the Gods,' Philadelphia, 1882), Prof. F. Delpino describes a species of ant, *Myrmecocistus melliger*, which has a caste of workers metamorphosed into honey-bags. The abdomen is distended into the size and form of a grape, and is full of honey, on which the other members of the colony feed when hungry. This ant appears to range through Mexico, New Mexico, Colorado del Sul, and possibly into California. It is of nocturnal habits, and obtains the

* Zool. Anzeig., xiii. (1890) pp. 86–90.
† See this Journal, 1889, pp. 380, 506, 745.
‡ Zool. Anzeig., xiii. (1890) pp. 69–71.
§ Malpighia, iii. (1889) pp. 349–52 (1 pl.).

honey from galls on a species of oak, *Quercus undulata*, growing on the young branches, and exuding, when young, copious drops of nectar. Prof. Riley states that nectariferous galls are also produced on the hickory, *Carya porcina*, by the attacks of a *Phylloxera*, the sweet juice probably resulting from the decomposition of tannin into gallic acid and sugar. The insect which produces the galls on the *Quercus undulata* is stated by Prof. Riley to be an undescribed species, for which he proposes the name *Cynips Quercus mellariæ*. Two Australian species of ant, *Mellophorus Bagoti* Lubb. and *Camponotus inflatus* Lubb., resemble the one above described in having the abdomen transformed into a honey-bag.

Termites of Isthmus of Panama.*—Mr. P. H. Dudley has an account of his observations on the habits of the "White Ants" of the Isthmus of Panama; the account of the battle of the white and yellow ants is particularly interesting, but the reader must refer to the original for details.

δ. Arachnida.

Spinning Apparatus of Geometric Spiders.†—Mr. C. Warburton contributes some new facts to our knowledge of the spinning apparatus of geometric spiders. A spider's line does not consist of many strands fused or woven together, but ordinarily of two or four distinct threads. The framework and the radii of circular snares are supplied by the ampullaceal glands. The acinate and pyriform glands are those which are mainly employed in binding up captured prey. The "trailing line" consists mainly of ampullaceal threads, some strengthened by others from the just-mentioned glands. The ground-line of the spiral is double only, and the two strands are bound together merely by the viscid matter which envelopes them.

He corroborates the statements of Apstein that the "attachment-discs" are furnished by the pyriform glands, that the tubuliform glands supply the silk for the egg-cocoon, that the viscid matter of the spiral is probably the product of the aggregate glands, and that, though the origin of the spiral ground-line is uncertain, it may proceed from the tubuliform orifices on the intermediate spinnerets.

Protective Resemblances in Spiders.‡—Mrs. E. G. Peckham points out that there are, among Spiders, two forms of protective modification. The first includes all cases of protective resemblance to vegetable and inorganic things—that is, all modifications of colour or of colour and form that tend to make their possessors inconspicuous in their natural relations; this she calls direct protection. Under indirect protection we have two classes: the spiders which are specially protected themselves, and those which mimic other creatures that are specially protected. Examples of the former of these two classes are afforded by spiders which become inedible through the acquisition of hard plates and sharp spines; and this modification of form is frequently accompanied by conspicuous colours, which warn their enemies that the spiders are unpalatable.

* Trans. New York Acad. Sciences, viii. (1889) pp. 85–114.
† Quart. Journ. Micr. Sci., xxxi. (1890) pp. 29–39 (1 pl.).
‡ Occasional Papers of the Natur. Hist. Soc. of Wisconsin, i. (1889) pp. 61–113 (1 pl.).

The first difficulty which is met with by a worker on this subject is that the meaning of a protective peculiarity can be determined only when the animal is seen in its natural home; the faithfulness, moreover, of a protective resemblance is much less striking when the animal is seen in the cabinet. For the details of this interesting essay we must refer the reader to the paper itself.

Sexual Selection in Attidæ.*—Mr. G. W. and Mrs. E. G. Peckham give an account of their observations on sexual selection in Spiders of the family Attidæ. However satisfactory Mr. Wallace's explanations may be when applied to birds and butterflies, they fail when applied to spiders; his theory would only partially explain the following facts. Among Attidæ males are more brilliant than females, young males nearly always resemble adult females, the males, when they differ from the females, depart from the general colouring of the group, and females, when they depart from the colouring of the group, approach the colouring of the males. Mr. Wallace's assumption that the male animal is constitutionally more active than the female is not true of spiders. On the contrary, it is the female that is the more active and pugnacious; in neither sex is there any relation between development of colour and activity; when the male is distinguished by brighter colours and ornamental appendages these adornments are not only so placed as to be in full view of the female during courtship, but the attitudes and antics of the male are at that time such as to display them to the fullest possible extent.

New Parasite of Lamellibranchs.†—Herr F. Koenike has a preliminary notice of a new parasite of *Anodonta* and *Unio* which he calls *Atax aculeatus*. It appears to have been seen by Claparède in its larval stage, but the author has been fortunate enough to obtain the adults of both sexes.

Teutonia.‡—Herr F. Koenike has published a detailed account of this new Hydrachnid from Gelnhausen in Hesse, to the preliminary notice of which we have already called attention; § only one pair of this interesting intermediate form seems to have as yet been found.

Pentastomum.||—Signor C. Parona describes *Pentastomum Crociduræ* sp. n. from the peritoneum of *Crocidura fuliginosa*, an insect-eating mammal of Burmah; the body is 10·5 mm. long, and 1 mm. broad. It has sixty-two rings, on which are numerous dermal pores arranged in transverse rows. *Pentastomum gracile* Diesing is reported as being found in the body-cavity of *Macrodon trahira*. A bibliography of *Pentastomum* completes the memoir.

ε. Crustacea.

Excretory Apparatus of Crayfish.¶ — M. P. Marchal gives a fresh account of the "green-gland" of the Crayfish. The saccule is not, as some authors have stated, a simple sac traversed irregularly by

* Occasional Papers of the Natur. Hist. Soc. of Wisconsin, i. (1889) pp. 3–60 (3 pls.).

† Zool. Anzeig., xiii. (1890) pp. 138–40.

‡ Arch. f. Naturg., lvi. (1890) pp. 75–80 (1 pl.).

§ This Journal, 1889, p. 509.

|| Annal. Mus. Civic. d'Istor. Nat. Genova, xxix. (1889–90) pp. 68–78 (1 pl.). See Centralbl. f. Bakteriol. u. Parasitenk., vi. (1890) p. 480.

¶ Comptes Rendus, cx. (1890) pp. 251–3.

vascular bands and septa; its cavity is divided into two principal compartments by a longitudinal median septum; the other septa are so arranged that a mould of the cavity exactly represents a racemose gland, the two chief lobes of which are determined by the large median septum. The green or cortical substance has neither the form ascribed to it by Grobben or by Wassiliew, but is a glandular plexus formed by canals, which anastomose among themselves on a unique plan. These canals give off diverticula, which swell out into ampullæ which form the vesicles of the green substance. The author accepts Wassiliew's account of the white substance, but absolutely denies the accuracy of the more recent statements of Szigethy and of Rawitz; and the same remarks apply to the communications between the constituent parts themselves.

We may regard the excretory apparatus of the Crayfish as formed of a septate sac tending to be racemose in form; of a glandular plexus which occupies the whole of the lower surface of the gland; of a twisted transparent tube; of a large white spongy cord; of a large bladder; and of an excretory canal.

Monstrilla.*—Mr. G. C. Bourne has some notes on this genus of Copepoda. Nearly all previous writers have regarded *Monstrilla* as a parasitic form, for no other reason than the absence of mouth-parts and alimentary tract. But every specimen that has been caught has been found in a free pelagic condition. The well-developed swimming feet, with their powerful musculature, and the total absence of any, except sexual, grasping organs, combine to speak against a parasitic habit. It is possible that *Monstrilla* may present an analogy with the Ephemeridæ, and the adult may be preceded by a predaceous larva having mouth-parts and an alimentary tract which, after a succession of rapid ecdyses, developes into the mature sexual form, whose only function is that of reproduction. Mr. Bourne acknowledges, however, that the undoubtedly young specimens which were taken by Dr. Norman afford no support to this suggestion, except that some of them have rudiments of gnathites which are entirely absent in adults. The Monstrillidæ may be regarded as a separate subfamily of the Corycæidæ. A new definition of the genus is given and six species are recognized; of these *M. longispinosa* from Plymouth is new.

Entomostraca of Bay of Marseilles.†—Prof. P. Gourret has a note on this subject. His recent researches have enabled him to increase the number of known Copepoda by twelve; fourteen Cirripedia are registered; the only known Ostracod is *Cypridina mediterranea* Costa, and two species of *Podon* are the only Branchiopods.

Vermes.

α. Annelida.

Polynoida of Spitzbergen.‡—Herr H. Trautzsch gives an account of eleven Polynoids collected at Spitzbergen, one of which only—*Harmothoe vittata*—is new. He afterwards proceeds to discuss their nephridia. He finds that, in their simplest condition, they are tubular

* Quart. Journ. Micr. Sci., xxx. (1890) pp. 565–78 (1 pl.).
† Arch. de Biol., ix. (1889) pp. 472–83 (2 pls.).
‡ Jenaische Zeitschr. f. Naturw., xxiv. (1889) pp. 61–104 (2 pls.).

organs, open at either end; the proximal end bores through the dissepiment of the next anterior segment, and the external orifice is at the tip of a neurally placed seta which corresponds to the hinder edge of its segment. In every nephridium there may be distinguished the funnel, the internal ascending nephridial loop, the sac, the outer loop, and the papilla. There is only one pair in a segment, and each nephridium has, contrary to Haswell's statement, only one outer orifice. These organs are found in all the segments except the first four and the last; they differ in structure in different segments, and those of the right side exhibit some differences from those of the left. The form of the anterior nephridia and of all in the young is the same; and this form is the primary one; that of the hinder nephridia and that seen during sexual maturity is a secondary one. The organs consist of two cell-layers, an outer which is peritoneal and an inner which is epithelial; the several form-elements of the latter appear to be ciliated cells, but they vary somewhat in character in different regions of the organs.

There have been many discussions as to the functions of these structures; Herr Trautzsch acknowledges that they have renal functions, and that this is primary; the anterior simpler nephridia have no other. The hinder tubes cease to be renal during the period of sexual activity, when they take on as a secondary duty the office of conveying sperm or ova; or, in other words, they undergo a change of function. At the same time the generative products are not driven to the exterior by the activity of the nephridia, but chiefly by contractions of the surrounding muscles.

New Genus of Oligochæta.*—Prof. A. G. Bourne describes a new worm, *Chætobranchus*, found in mud from a pond in Madras town. The worm attracted him by its branchial processes, which could be seen with the naked eye. The most remarkable feature is the presence of dorso-lateral processes, of which there is a pair to each of the anterior segments; they are obviously branchial in function. Each is virtually a hollow prolongation of the body-wall; the epidermis is bounded externally by a distinctly visible cuticle, through which very fine cilia project; at the extremity are a few stiff processes which are doubtless sensory in function. Into each of the longer processes (about the first fifty) there runs a loop of the lateral vessel.

Entirely contained within each process are the processes of the setæ, all in the case of the more anterior, or some in that of the more posterior, which belong to the dorsal bundle; there are no muscular structures in the branchial processes, which are kept fairly rigid, are moved by the dorsal setæ, and thus serve the worm as locomotor organs. There seems to be no doubt that this worm has been noticed by Semper, and the author proposes to call it *Chætobranchus Semperi*.

Anatomy of Dero.†—Mr. F. E. Beddard has some notes on the anatomy, chiefly of the reproductive organs, of a species of *Dero* (*D. perrieri*), found by Messrs. Bolton, of Birmingham. There can be no doubt that this annelid has been correctly referred to the Naidomorpha, but it has not genital setæ on the sixth segment.

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 83–9 (1 pl.).
† Proc. Zool. Soc. Lond., 1889 (1890) pp. 440–4 (3 figs.).

Embryology of Earthworm.*—Prof. E. B. Wilson gives a detailed account of his observations on the embryology of the earthworms—*Lumbricus terrestris*, *communis*, and *fœtidus*. He finds that the cleavage is unequal and variable, and results in the formation of a blastula containing a large blastocœl. The gastrula is formed by embolic invagination. The blastopore, which at first occupies the entire ventral surface, narrows to a slit-like form, when its longer axis coincides with the long axis of the body; it closes from behind forwards, but its foremost portion persists as the mouth. The germ-bands are, from the first, united in the middle line behind the posterior lip of the blastopore, but remain separate in front until the establishment of the mouth, when they extend forward, join in the median dorsal line, and thus form a complete ring surrounding the region of the primitive blastopore.

The entire mesoblast is derived from a pair of primary teloblasts that lie at the posterior ends of the germ-bands, and no mesoblastic elements arise from the ectoblast which overlies the germ-bands. The primary teloblasts are differentiated in the course of the cleavage, and are pushed into the segmentation cavity some time before the commencement of gastrulation. The cells formed by the continued proliferation of these primary cells are very early differentiated into two groups. Those of the first have histologically the character of mesothelium, form the mesoblastic parts of the germ-bands in the trunk-region, and inclose the paired cœlomic cavities; it is proposed to term them the trunk-mesoblast. The cells of the second group arise by migration from the dorsal and anterior parts of the germ-bands, and may be called the migratory mesoblast. Histologically, they have the character of mesenchyme, and form a nearly complete investment of the body in the trunk region, but they also extend forward to form the cephalic mesoblast of the prostomium.

When fully established the germ-bands consist, as in the Hirudinea, of three strata of cells:—an outer (ectoblast), one cell in thickness, which arises directly from the outer layer of the gastrula and persists as the hypodermis; an inner layer (mesoblast) consisting of granular cells derived from the two primary teloblasts, and giving rise to muscles, septa, blood-vessels, peritoneal epithelium, reproductive organs, and the inner part of the nephridia. Between these two there lies a layer which agrees in general histological character with, and is indirectly derived from the former; it gives rise to the nervous system, the outer part of the nephridia, and the setigerous glands and setæ.

This middle stratum is arranged in a series of distinct longitudinal cell-rows, which, in early stages, lie at the surface and form part of the general ectoblast, but afterwards sink beneath and are covered by the rest. Until a comparatively late stage each row terminates behind in a large cell or teloblast which is the parent of the entire row, and thus of all the structures to which the row gives rise; they may be called neuroblast, nephroblasts, and lateral teloblast, and may, collectively, be called the anterior teloblasts to distinguish them from the posterior or mesoblastic teloblasts which lie at the extreme hinder ends of the germ-bands. These anterior teloblasts first appear shortly after the completion of gastrulation, when they lie at the surface.

* Journal of Morphology, iii. (1889) pp. 387-462 (7 pls.).

The prostomium is formed by the union of the anterior ends of the germ-bands; the mesoblastic part arises by the forward growth and union in the median line of the mesoblastic bands—a process which is effected by proliferation and migration of the mesoblast cells already formed, and not by the formation of new mesoblastic elements from the superjacent ectoblast. The prostomial cavity is from the very first unpaired. The preoral or cephalic ganglia are differentiated out of the front ends of the neural rows, formed by the neuroblasts, at a time when these rows are fused with the ectoblast, and before they have met in the median line in front of the mouth. There is, therefore, no median apical plate, but only a pair of lateral ectoblastic thickenings continuous with the neural rows.

As regards the mesoblast the author is fully convinced that the whole of the "epiblastic mesoblast," which Kleinenberg believed to be derived directly from the outer layer, is simply the middle stratum which he failed to distinguish from the inner or mesoblastic stratum. This is a matter of importance owing to the views lately put forward by that author in his paper on *Lopadorhynchus*, and has some bearing on his denial of the existence of the mesoblast as a primary feature of development.

Prof. Wilson thinks that the development of *Lumbricus* can be most simply and clearly interpreted in accordance with Sedgwick's hypothesis:—(1) The ancestral form possessed an elongated ventral blastopore that gave rise to both mouth and anus by closure in the middle region; (2) the mesoblast and the nervous system originally formed a ring around this blastopore, and subsequently underwent concrescence throughout its middle portion as the blastopore closed; (3) the cœlomic cavities were arranged in a continuous series in the mesoblastic ring, each lateral cavity lying opposite a corresponding cavity on the other side of the body, and a single anterior cavity lying in front of the mouth and giving rise to the head-cavity; (4) the larval trochosphere is secondarily derived from such a form by retardation or temporary suppression of the trunk-region, and early and extensive differentiation of the head-region.

Embryology of Earthworm.*—Dr. R. S. Bergh has a preliminary notice of his recent studies on the development of the earthworm. He has particularly directed himself to an examination of the origin of the stripes of cells and primitive cells described by Wilson, but which Bergh failed to find in *Criodrilus*. In quite young embryos the number of such cells is very small. For example, in an almost spherical embryo, 0·125 mm. long, there are only two on either side; in an embryo 0·16 mm. long there were three primitive cells on either side, and it is only from the two inner on either side that quite short cell-rows arise. Later on the median of the three primitive cells divides into two, and all four begin to produce cells. It is, for various reasons, very probable that all the eight primitive cells arise from a single cleavage-sphere.

The primitive cells, and the rows to which they give rise, are at first quite superficial in position, and the three primitive cells are to be

* Zool. Anzeig., xiii. (1890) pp. 186-90.

found in the same place, even when the young are one and a half mm. long. The cell-rows, however, are ordinairly covered by epidermal cells, with which they have not the least connection.

Although the author agrees with Wilson in believing that row I. (of Wilson's nomenclature) passes into the ventral ganglionic chain, he does not find that the development of that apparatus is as simple as is ordinarly stated. A plexus of nerve-cells is developed along the middle ventral line long before the cells of the "neural row" develope into nervous elements. These ventral cells are ordinarly uni- or bipolar. The author is of opinion that these nervous cells have a different genetic history from the neural cells, and that they arise from ordinary ectodermal cells.

The author traces briefly the history of the other rows, and expresses a hope that he will soon be able to publish his results in detail.

Anatomy of Earthworms.*—The more important points in Mr. F. E. Beddard's paper, in addition to the description of three new species of *Acanthodrilus*—*A. antarcticus*, *A. Rosæ*, *A. Dalei*—and of one new *Perichæta*—*P. intermedia*—appear to be the following:—

He describes the ciliation of the spermathecal appendix in *A. Rosæ*, and the presence in *Eudrilus* of two pairs of ovaries connected by oviducts with a single aperture on either side; these oviducts are continuous with the ovaries. *P. intermedia* differs from most species of *Perichæta* in having a single pair of nephridia in each segment, and in having a tubular atrium like that of *Acanthodrilus*; it has also functional egg-sacs, wherein the ova undergo their development surrounded by a follicular epithelium, and with a mass of germinal cells attached to one pole, as in some members of the "limicolous" division of the Oligochæta. *Perichæta* is provided with a peripheral nerve-plexus which is specially developed in the neighbourhood of the setæ; *Acanthodrilus* has a subintestinal, and *Perichæta* and *Thamnodrilus* a subneural blood-vessel.

An account is given of the minute structure of the spermathecæ and the spermathecal appendices in *Perichæta* and *Acanthodrilus*; spermatozoa are only found in the appendices, the epithelium of which has largely undergone degeneration into a viscous substance, in which the spermatozoa are imbedded. The former of these two genera has epidermic glands, which are, possibly, equivalent to the capsulogenous glands of *Lumbricus*; and both of these possess organs which probably correspond to the so-called pericardial glands of *Lumbriculus*; they consist of a network of capillaries with numerous spherical dilatations which are crowded with cells. The whole network forms a compact series of organs clothed with chloragogen cells, which, though limited to the anterior segments, exhibit a more or less perfect metameric arrangement. Special glycogenic organs appear to exist in *Ac. georgianus* in the form of a series of paired sacs attached to the septa.

The Rings of Piscicola.†—Dr. S. Apáthy has reinvestigated the relation of rings to somites in *Piscicola piscium*. That there are three rings to a somite is an old error; that there are a dozen was the

* Quart. Journ. Micr. Sci., xxx. (1890) pp. 421–79 (2 pls.).
† Zool. Anzeig., xii. (1889) pp. 649–52.

author's previous conclusion; now, however, he maintains that there are fourteen. But the fourteen are derived from a primitive twelve, so that *Piscicola* forms no exception to the rule of three which persists among Rhynchobdellidæ.

Phymosoma varians.*—Mr. A. E. Shipley has published an account fuller than that which we have already † noticed of the structure of this Gephyrean. He now, further, urges that there are reasons for maintaining *Phoronis* in its old position as a form closely allied to the more normal Gephyrea inermia. In addition to points already emphasized by Lankester, he urges that the skeletal tissue found in *Phymosoma* has its homologue in *Phoronis*, while the thin membranous web which forms the "collar" of *Phymosoma* appears to correspond very closely with the calyx or web which surrounds the base of the head in *Phoronis*. The absence in the unarmed Gephyrea of mesenteric partitions in the post-oral body-cavity may be accounted for by the twisting of the intestinal loop in the more normal genera; and the radial muscles are, in all probability, the remains of a mesentery which, in the ancestral form, was continuous.

β. Nemathelminthes.

Filaria sanguinis hominis.‡— Prof. C. Sibthorpe gives a short account of this worm, and figures drawings made by Prof. A. G. Bourne; the latter adds a description of his preparations. One is that of the caudal extremity of the male which has never yet been described. The spicules would appear to differ from those of any known nematode.

The Nematode of Beetroot.§—Dr. J. Ritzema Bos writes the history of the beetroot disease, as elucidated by the researches of Kühn, Strubell, ‖ and others. Millipedes such as *Iulus*, beetles such as *Atomaria linearis*, fungi such as *Sporidesmium putrefaciens* and *Peronospora schachtii* were known to attack the beetroot, but the prevalent disease was usually regarded as a consequence of soil-exhaustion by continuous beetroot crops. With great patience Kühn demonstrated that this was not the real cause, and Strubell, by tracing the disease to a nematode parasite—*Heterodera schachtii*—verified the opinion which even in 1859 was expressed by Schacht. This worm is not far removed from the genus *Tylenchus*, to which Ritzema Bos has recently given so much attention, and has allied species in *H. radicicola*, which forms galls on many plants, and *H. javanica* from the sugar-cane. A discussion of its characters and life-history (already recorded in this Journal) forms the second part of the present paper, which closes with an account of preventive measures.

Nematodes in Vinegar.¶—Dr. G. Lindner discusses the occurrence and hygienic import of the Anguillulidæ which are common in weak or impure vinegar. They are "monogenic," and included among the Rhabditidæ. The males and females respectively measure 1–1·5 mm.

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 1–28 (4 pls.).
† See this Journal, 1889, p. 642.
‡ Proc. Roy. Irish Acad., i. (1889) pp. 202–5 (1 pl.).
§ Biol. Centralbl., ix. (1890) pp. 673–83, 705–16 (11 figs.).
‖ See this Journal, 1888, p. 737.
¶ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 633–8, 663–8, 694–9.

and 1·5–2·5 mm. in length. The worms move actively in a fluid medium, creep slowly in thick concoctions, or coil together in complicated knots. Dr. Lindner kept *Anguillula oxophilæ* in various cultures; they thrive well on a diet of white of egg, withstand even tolerably strong vinegar, are killed at once by pure acetic acid, are very slightly perturbed by artificial digestive cultures, live well on fruits, bulbs, &c. The females reproduce viviparously or oviparously, according to the nutritive medium and temperature, but soon die after reproduction; nor are the males long-lived. They flourish best between 16° and 30° C., and are killed by a temperature over 42° C., or under the freezing point; on light and air they are very slightly dependent, but to drought very sensitive. After desiccation for three or four hours no revivification even of the eggs was observed. Differences in size followed differences of culture, and the worms have great powers of adaptation to most diverse conditions. Their natural home seems to be in moist mud and in putridity, but they are rare in drinking or running water. That millions of germs float in the air is a fable. How they get into the vinegar is uncertain, but they probably insinuate themselves at certain stages of its manufacture from brandy. In vinegar prepared from wine by the quick process they are very rare. Dr. Lindner describes some infection experiments, and reasonably urges that, although the "vinegar-eels" are not exactly dangerous, it is at once safer and more appetising to make sure either that the vinegar is of the better sort, or at least boiled and filtered.

Parasites in the Blood of the Dog.*—Dr. P. Sonsino finds that the dog is subject to infection by at least one species of Nematode, which discharges myriads of embryos into the circulation. This hæmatozoon is *Filaria hæmatica* (Gruby and Delafond) or *F. immitis* (Leidy), and inhabits not only the right cavity of the heart or pulmonary artery, but also the subcutaneous connective tissue, intermuscular connective, and various parts of the vascular system. The intermediate host is the louse *Hæmatopinus pilifer*, which receives the *Filaria* embryos from the dog's blood. It seems that even the fœtal dog may be infected by the parasite. Sonsino agrees with Grassi in maintaining that *Tænia cucumerina* of the dog has two intermediate epizoic hosts, *Trichodectes latus*, and also the above-mentioned louse, the latter being probably infected in its larval stage.

Filaria immitis.†—Herr O. Deffke reports the case of a five-year old dog, born in Japan, and brought thence to Germany, which suffered from chronic interstitial nephritis. Fifty examples of *Filaria immitis* were found in the right auricle and ventricle; a large number of embryos were found in the blood, but no eggs were detected. The substance of the kidney was seriously affected.

Ascaris halicoris.‡—Herr C. Parona reports on the Nematodes collected at Assab by Dr. V. Ragazzi. In one host twenty-six examples of *A. halicoris* were seen, and in another sixty-four; this species resembles

* Atti Soc. Tosc. Sci. Nat., x. (1889) pp. 20–65 (1 pl.).
† Monatshefte f. Prakt. Thierheilkunde, i. (1889) 16 pp. (4 figs.). See Centralbl. f. Bakter. u. Parasitenkunde, vii. (1890) p. 515.
‡ Annali di Mus. Civico, vii. (1889) 14 pp. (1 pl.). See t. c., p. 514.

in many points *A. lumbricoides*, but the cellular layer of the intestine forms high folds, and a longer cæcal sac is connected with the œsophagus. Three other Nematodes are also noticed.

γ. Platyhelminthes.

Australian Land Planarian.*—Mr. A. Dendy gives an account of the anatomy of *Geoplana spenceri*, a new land Planarian remarkable for the intense blue colour of its ventral surface. We are not justified as yet in recognizing more than two genera of Australian land Planarians, *Geoplana* with many, and *Rhynchodesmus* with only two eyes. It has been lately observed by Mr. C. C. Brittlebank that these creatures live on animal food, as Moseley has already urged.

Fresh-water Triclades have the superficial muscular system more highly developed and containing more layers than the terrestrial forms; on the other hand, the latter have a much more extensive deep muscular system than the former; this is, doubtless, in correlation with the changed habitat and the thicker form of body.

The lining epithelium of the alimentary canal consists primitively of a single layer of amœboid cells which take in and digest food-particles. At the anterior end of the alimentary canal whither, probably, only a little food can find its way, the cells retain their amœboid character and remain in a single layer. Nearer the mouth, where there is more food to be digested, the cells become so numerous that they are set in irregular heaps. As they become densely charged with granules (excretory products) and their protoplasm dwindles away they become mere thin-walled bags, full of granules; the wall of the cell ruptures and the granules are discharged into the alimentary canal and are ejected through the mouth. The author gives a careful account of the views of preceding writers and of his own observations on the rhabdites; as to their function he suggests only that they may make their possessor extremely unpalatable, and may also serve to increase the stickiness of the slime.

All the organs of the body are described in detail.

New Land Planarians from Sunda Islands.†—Dr. J. C. C. Loman describes the land Planarians found by Prof. M. Weber in his travels in Java and Sumatra. Fourteen new species, two of which belong to *Bipalium*, two to *Geoplana*, and two to *Rhynchodesmus*, are described. *B. ephippium*, *G. nasuta*, and *R. megalophthalmus* were subjected to a close anatomical investigation, the results of which are here given. The genus *Dolichoplana* Moseley does not present sufficient differences in its musculature from *Rhynchodesmus* to justify us in regarding it as distinct. The eye of this last genus presents structural characters which indicate that it is of much higher organization than the ordinary Turbellarian eye. On the whole the anatomical characters of these three genera are strikingly similar.

Interpretation of Cestodes.‡—Prof. C. Claus discusses the morphological and phylogenetic interpretation of tapeworms. Starting from *Caryophyllæus*, which he regards as homologous with a Trematode, he

* Trans. Roy. Soc. Victoria, 1889, pp. 50–94 (4 pls.).

† 'Zoologische Ergebnisse einer Reise in Niederländisch-Ost-Indien, herausgegeben von Dr. Max Weber,' Leiden, Heft i. (1890) pp. 131–58 (2 pls.).

‡ Arbeit. Zool. Inst. Univ. Wien (Claus), viii. (1889) pp. 313–26.

traces the gradual complication of life-history on to the Tæniidæ, and finally to *Echinobothrium*, whose liberated joints persist for some time and even increase in size. "The development of the Acalephæ may be defined as alternation of generations which in certain cases by contraction and abbreviation becomes metamorphosis; while the development of the Cestodes is to be interpreted as metamorphosis, which by the individualization of certain products of growth may give rise to variously complicated forms of alternation of generations." The sporocysts and rediæ in the development of *Distomum* are heterogonic, sporogonic larvæ, with parthenogenetic or pædogenetic reproductive cells; they are morphologically equivalent to the cercariæ, as the latter are to the cysticercoids of Cestodes. Claus elaborates these comparisons, and brings the life-histories of Trematodes and Cestodes into relation with the phylogenetic development of their hosts.

Helminthological Notes.*—Dr. P. Sonsino discusses those species of *Distomum* which are allies of *D. conus* Creplin. The genus *Distomum* s. str. is characterized by the position of the genital aperture between the oral and the ventral sucker. A subgenus *Dicrocœlium* is then distinguished, in which the intestinal cæca are prolonged as far as the posterior end of the body. Within this subgenus the members of one section have terminal posterior testes, behind the oviducal folds and ovary, and one behind the other. Finally, the section thus specified includes the group of which *D. conus* is type. In these the ventral sucker is smaller than the oral, the short œsophagus bifurcates far in front of the ventral sucker, the anterior fourth of the body has a markedly conical form, and all the members live in the bile ducts of carnivorous mammals or of man. The testes are ramified in *D. endemicum* and *D. sinense*, lobed in *D. conus* and *D. felineum*, aggregated in *D. campanulatum* and *D. conjunctum*, doubtful in *D. truncatum.*

Parasites of the Salmon.†—Herr F. Zschokke has studied the parasites of the salmon, partly with the hope of thereby verifying the statement that the fish fasts as it ascends the rivers, and even after spawning is over. In forty-five salmon from the Rhine, eleven species of parasites were found, which were almost wholly the wonted guests of marine hosts, e.g. *Agamonema capsularia*, *Ascaris clavata*, *Distomum varicum*, *D. reflexum*, *Tetrarhynchus solidus*, *Rhynchobothrium paleaceum*, &c. The author found a new species of *Distomum*, *D. miescheri*; he identified *Bothriocephalus infundibuliformis* and *B. proboscideus*, and dissents from Küchenmeister's conclusion that the salmon is the principal intermediate host of *B. latus*, for no very young larvæ of this species were present. It is noteworthy that no parasites occurred below the pyloric cæca, a fact which suggested that the fasting fish loses in the river many of the guests which are found in the intestine during marine life. Notes on the eleven parasites are communicated.

Peculiar Tetrarhynchid Larva.‡—Herr E. Lönnberg found in the abdominal cavity of a *Gadus virens* a single example of the *Tetrarhynchus*

* Atti Soc. Tosc. Sci. Nat., vi. (1889) pp. 273–85.
† Verh. Naturf. Gesell. Basel, viii. (1890) pp. 761–95 (1 pl.).
‡ Bihang til Svenska Vet. Akad. Handlingar, xv. 4, No. 7 (1889) 48 pp. (3 pls.). See Centralbl. f. Bakteriol., vii. (1890) p. 346.

linguatula found by P. J. van Beneden in *Scymnus glacialis*. He was able to distinguish a scolex, a body, and a small round appendix at the hinder end; the body was marked by deep transverse grooves, but there was no sort of segmentation. The appendix contained rudiments of both male and female organs. He thinks this form should be separated from the Tetrarhynchidæ, and formed into a new genus allied to the Bothriocephalidæ. It may be called *Cœnomorphus*, and defined thus:—"Scolex magnus bothriis duobus oppositis, dorso-ventralibus, angustis, rimæformibus, limbo calloso, capiti immersis. Proboscides quatuor perbreves, crassæ, subclavatæ, uncinis armatæ, in vaginas retractiles. Bases vaginarum oblongæ. Collum cylindricum. Corpus depressum, tæniiforme, rugosum, sed inarticulatum, appendice postica rotundata." The author regards this form as being a cestode-nurse of very considerable size in which the genital organs are beginning to be developed, and which has mature sperm before there are any indications of segmentation.

Cysticercoid with Caudal Appendages in Gammarus pulex.*—Dr. O. Hamann describes some tailed cysticercoids which he found in *Gammarus pulex*. The investment by which they were contained was attached to the digestive tract; the cysticercoids were about 1·3 mm. long, and 0·5 mm. of this was taken by the tail. The author gives an account of the various stages of development that he was able to observe. The other host appears to be the Duck.

δ. Incertæ Sedis.

Two new Species of Rotifers.†—Mr. D. Bryce states that *Metopidia rhomboidula* might be easily passed over as *M. triquetra*, but the lorica has almost the shape of the ace of diamonds. *Euchlanis subversa* is, as its specific name is meant to show, a *Euchlanis* turned upside down, the ventral plate being considerably the larger, and strongly turned up at the sides.

Echinodermata.

British Fossil Crinoids.‡—Mr. F. A. Bather has commenced a series of papers on British Fossil Crinoids. After a historical introduction he gives a statement as to the terminology which he intends to adopt—a matter of some importance in the present state of this group. The plate is illustrative of the structure of the dorsal cup in the genera of Fistulate Crinoids.

Genesis of Actinocrinidæ.§—Mr. C. R. Keyes has been led by his study of the Actinocrinidæ to some conclusions which are, he thinks, of much wider bearing. He finds that it is clearly indicated that a large proportion of the genera date back much further geologically than actual observation shows. At times, in the phylogenetic history of a group, variations appear to go on with broad and rapid strides, and the

* Jenaische Zeitschr. f. Naturwiss., xxiv. (1889) pp. 1–9 (1 pl.).
† Science-Gossip, 1890, pp. 76–9 (5 figs.).
‡ Ann. and Mag. Nat. Hist., v. (1890) pp. 306–34 (1 pl.).
§ Amer. Natural, xxiv. (1890) pp. 243–54 (3 pls.).

organisms survive through rapidly changing physical conditions. When the changes of environment became too rapid, the forms either ceased to exist or retrograded, became depauperate, and finally extinct; this may be illustrated by *Batocrinus*, *Dorycrinus*, and *Dichocrinus*. Variation may go on in one portion of an organism without materially affecting other parts. The Actinocrinidæ show a decided tendency throughout their existence to increase the distal extent of their rays. This was accomplished by simple branching of the free arms, as in *Megistocrinus*, by the lateral expansion of the arms, as in *Eretmocrinus*, or by radial extension of the calyx-brachials, as in *Teleiocrinus* and others.

Ambulacral and Adambulacral Plates of Starfishes.*—Mr. J. W. Fewkes comes to conclusions regarding the homologies of these plates, which differ from the generally received doctrines. He finds that there is no difference in the way the mouth-parts of typical representatives of the groups known as Asteriæ Ambulacrariæ or A. Adambulacrariæ are developed. The arm of a starfish is made up of somites, and the water-vascular system of vessels may be supposed to be primarily surrounded by a calcification. The theoretical ring of calcification is most closely reproduced in its typical form in the plates surrounding the mouth. The ambulacrals and adambulacrals are portions of the annular calcification of successive segments, and are serially homologous. The ambulacrals of starfishes are not represented in sea-urchins except around the mouth, when they appear as auricles. The adambulacrals of starfishes represent the ambulacrals of sea-urchins and complete the external portion of the problematical ring of calcification, which is absent in Asteroids. The marginal plates of *Asterias* are homologous with the so-called adambulacrals of sea-urchins.

With regard to spines it seems to Mr. Fewkes to be necessary to distinguish the ordinary spines of the adambulacral arm-plates, the hook-shaped spines found on each side of the terminal in some young Ophiurids, or on the adults of others, the fins of *Ophiopteron*, and the fan-shaped spines of *Asterias*.

French Holothurians.†—M. E. Hérouard gives an account of the Holothurians found on the coast of France. He regards a Holothurian as an Echinoderm whose plane of symmetry does not correspond to that of the Spatangoids; the left ventral radius of the latter is the homologue of the median ventral radius of a Holothurian. The inter-radius which corresponds to the madreporite of Echinoids is, therefore, in the median dorsal line.

The integument presents three zones, the innermost of which is muscular; the intermediate one is formed of an inner nervous and an outer connective layer, and belongs to the "amœbophorous system"; the outermost layer is connective, is very strong, and contains the calcareous corpuscles; it plays the part of a protective organ like the test of an Echinoid. In some species there is a circumanal apparatus, the radial plates of which are the homologues of the ocular plates of Echini. The calcareous corpuscles are always formed of a hexagonal plexus, and

* Proc. Boston Soc. Nat. Hist., xxiv. (1889) pp. 96–117.
† Arch. Zool. Expér. et Gén., vii. (1889) pp. 535–704 (8 pls.).

those of the young are often more varying and complicated than those of the adult.

In the mesentery we have to distinguish a dorsal part divided into two, the upper of which depends from the pharynx and œsophagus, and represents the œsophageal mesentery of Echini, and the wall of the hydrophoric sac of Starfishes; there are lateral and ventral parts and an intermediate or internal mesentery, the development of which is proportional to the depth of the intestinal loop. The endothelium of the general cavity contains stomata. The "aquopharyngeal bulb," which is situated at the superior extremity of the digestive tube, contains, in the Pedata, an axial part—the pharynx, and a peripheral part which is formed by the calcareous corona and the central parts of the aquiferous apparatus. These two parts are separated by the circumpharyngeal sinus, which is an appendage of the general cavity. The upper extremity of this sinus forms the circumbuccal sinus.

The aquiferous system of the Pedata is similar to that of Echinoids; it is made up of a ring situated at the base of the pharynx, to which are appended the sand-canal or canals and the Polian vesicles; each of the radial vessels given off from it consists of three portions—one dilated, one coronal, and one ambulacral. The two latter have, at their sides, more or fewer orifices which establish communication between the vessel and the ambulacral tubes; all these orifices are provided with a valve. The tentacles are ambulacral tubes depending from the coronal portion, and adapted to special functions. The aquiferous apparatus is essentially locomotor, and is entirely distinct from the amœbophorous system. The endothelium of the former system, as well as that of the general cavity, only adheres to the subjacent layer by filiform prolongations, and thus a subepithelial lacuna is formed.

In addition to the nerve-trunks common to them and Echini, Holothurians have five internal ambulacral bands, the upper ends of which bifurcate and bend inwards to the aquopharyngeal bulb. The superficial nerve-plexus of Echini is represented by a deep nervous plexus. The amœbophorous system, like that of Echini, is formed by a system of free and one of connective lacunæ. The former is composed of a circumpharyngeal ring, of an internal marginal lacuna, and of an external marginal lacuna, with which a genital lacuna is connected; there are also five radial lacunæ. The second system is placed in the median zone of the wall of the body, of the digestive tube, and of the gonads, in the axis of the circumpharyngeal and circumcloacal tracts, and in the mesenteries. The dendritic organs are, primarily, hydrostatic in function, but are also respiratory and excretory, and probably serve also for amœbocystogenesis. The Cuvierian organs are glandular, and not defensive, as has been asserted by various writers.

Excavations by Sea-Urchins.*—Mr. J. W. Fewkes thinks that the excavations sometimes made by *Strongylocentrotus drobachiensis* on the coast of Grand Manan are made by means of its teeth and spines, combined with motions of the animal produced by waves and tide. Though primarily protective, the holes also serve to contain a sufficient quantity of water when the animal is uncovered.

* Amer. Natural., xxiv. (1890) pp. 1–21 (1 pl.).

Madreporic System of Echinoderms.*—Prof. M. M. Hartog draws attention to the fact that M. Cuénot, in his anatomical studies on Ophiurids, first ignored and then misquoted him.

Cœlenterata.

Alcyonaria of the 'Challenger.'†—Prof. T. Studer has issued a report of some specimens of Alcyonaria found after the main report went to press. Three new species of *Siphonogorgia*, a new *Bebryce*, and a new Plexauroid are among the forms here described.

Antipatharia of the 'Challenger.'‡—Mr. G. Brook has published a report on this slightly known group which is of great interest to the student. He treats of the general morphology of these zoophytes under the heads of: (1) the homologies of the mesenteries; (2) complete and incomplete mesenteries; (3) dimorphism; (4) colony formation; (5) cœnenchyma; (6) skeleton formation; (7) origin and arrangement of spines; and (8) retrogressive development.

The old classification of known forms into two groups is retained, but that which contains *Gerardia* only is now called Savagliidæ, and a new division has to be made for *Dendrobrachia* g. n., which is called Dendrobrachiidæ. The Antipathidæ, which form, of course, the great bulk of the group, are divided into the Antipathinæ, which contains the genera *Cirripathes* (emended), *Stichopathes* g. n., *Leiopathes* and *Antipathes* (emended), *Antipathella*, *Aphanipathes*, *Tylopathes*, *Pteropathes*, and *Parantipathes*—all new; in the Schizopathinæ we find the new genera *Schizopathes*, *Bathypathes*, *Taxipathes*, and *Cladopathes*. Several species are still relegated to the group "incertæ sedis," and a few are called "species dubiæ."

No species belonging to the family Antipathinæ has yet been obtained from depths exceeding 900 fathoms; the Schizopathina, on the other hand, are chiefly abyssal forms, and in them a considerable increase in depth is associated with a simplification in the type of corallum and a greater isolation of the dimorphic zooids.

Bilaterality in Corals.§—Dr. A. Ortmann describes *Cylicia tenella* Dana, in which most of the calices are excentric in relation to the columellæ, and bilateral in the disposition of their septa. He interprets this as a primitive character, consonant with such other features in *Cylicia* as the imperfect colonies and the simple structure of the individual calices. His general theory of bilaterality is that it was the primitive condition, most marked in solitary Rugosa, often seen in the younger less compressed members of a colony, and cropping up occasionally in such forms as *Cylicia*.

Development and Relationships of Actiniæ.‖—Dr. Th. Boveri has studied the development of several Hexactiniæ, Edwardsiæ, and Ceriantheæ. As type of the Ceriantheæ he investigated *Arachnactis albida*,

* Zool. Anzeig., xiii. (1890) pp. 136–7.

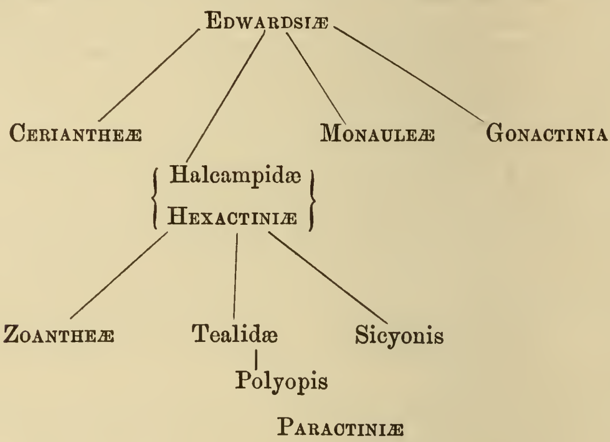
† Reports of the Voyage of H.M.S. 'Challenger,' xxxi. Part lxxxi. (1889) 31 pp. and 6 pls.

‡ Reports of the Voyage of H.M.S. 'Challenger,' xxxi. Part cxxxi. (1889) 222 pp. and 15 pls.

§ Zool. Anzeig., xii. (1889) pp. 643–6.

‖ Zeitschr. f. Wiss. Zool., xlix. (1889) pp. 461–502 (3 pls.).

and found that it exhibits a distinct *Edwardsia*-stage in which the dorsal and ventral pairs of septa have their muscle-layer on the sides turned towards the median plane, while the muscle fibrils of the lateral septa are disposed on the same side as those of the dorsal septum. Of Hexactiniæ with a bilateral disposition, *Cereactis aurantiaca* was studied, along with other larvæ of the biradiate type. An *Edwardsia*-stage was again detected. Boveri therefore derives Ceriantheæ and Hexactiniæ from *Edwardsia*-like forms. He believes the *Cerianthus*-type to have arisen from an *Edwardsia*-like form by the appearance of new pairs of septa between the dorsal directive pair. Similarly, he finds in species of *Halcampa* illustrations of the transition from Edwardsiæ to Hexactiniæ. For the various groups of Actiniæ he proposes the following genealogical scheme:—



Hoplophoria coralligens.*—Dr. H. V. Wilson gives a description of a new Actinian found in the Bahamas, which is, unfortunately, based on a single female specimen. After a short account of its anatomy, the author discusses the morphology of the stinging organs. At first sight they appear to be modified tentacles, but each organ is derived from a chamber which also gives rise to one of a cycle of tentacles, and the longitudinal musculature of the tentacles is ectodermal, while that of the stinging organs is endodermal. In position and essential structure the four stinging organs of *Hoplophoria* agree with the marginal sacs of *Actinia mesembryanthemum*, and the author regards the two structures as homologous. The ancestor of the new genus very probably had a circle of small sacs, but when the habit of living in a hole was acquired, certain of these sacs were transformed into large and formidable weapons, while the rest were lost.

In many points *Hoplophoria* agrees with the Antheidæ, but differs in the possession of only four marginal sacs, which are highly developed, in that only the six primary pairs of mesenteries reach the œsophagus, while only four mesenteries bear generative organs, but these several points have, it is argued, but little classificatory importance.

* Studies from Biol. Lab. John Hopkins Univ., iv. (1890) pp. 379–87 (2 pls.).

Thelaceros rhizophoræ.*—Mr. P. Chalmers Mitchell describes a new genus of Actinians obtained by Dr. Hickson in a mangrove swamp in Celebes. It appears to form the type of a definite family closely allied to the Corallimorphidæ, which may be called Thelaceridæ, and thus defined:—Hexactiniæ without a sphincter, cinclides, or acontia; with numerous accessory rudimentary tentacles, so that more than one tentacle communicates with a radial chamber; the normal tentacles are covered by small compound hollow protuberances. The accessory tentacles are rudimentary. The Thelaceridæ appear to have protected themselves by a sudden vertical contraction, by which they withdrew themselves into the mud, and a continual selection favoured those with strong longitudinal muscles. The oral disc remaining uncontracted, the tentacles were, in correlation with this habit, peculiarly modified. The author calls attention to our incomplete knowledge of other Stichodactylinæ, and suggests that the Discosomidæ, with the abnormal radially arranged tentacles and unretractile disc, and the Cryptodendridæ, may possibly stand on either side of the Thelaceridæ.

Anatomy of Madreporaria.†—Dr. G. H. Fowler, in commencing his fifth memoir on the anatomy of the Madreporaria, remarks that the time is hardly yet ripe for a discussion of those modifications which are likely to be ultimately introduced into the systematic classification by further morphological study. He gives, therefore, simple descriptions of anatomical structure, and in this memoir deals with *Duncania barbadensis*, *Madrepora* sp., *Galaxea esperi*, *Heteropsammia multilobata*, and *Bathyactis symmetrica*. *Duncania* is found to be a true Madreporarian, and will probably be ultimately proved to be allied to such forms as *Zaphrentis*. Figures are given of the typical structure of the genus *Madrepora*. A vertical section between two polyps of *G. esperi* shows (1) the body-wall of ectoderm, mesoglœa, and endoderm; (2) a space which is part of the common cœlenteron of the colony; (3) a layer of endoderm, mesoglœa, and (?) calicoblasts, which directly overlies (4) the cœnenchyme itself.

Heteropsammia, in common with *Stephanoseris* and *Heterocyathus*, has a pear-shaped body; some species of all these genera are known to derive the curvature of the chamber from settlement on a heliciform shell, and it is also known that a large number of Gephyrea normally inhabit heliciform shells, and Dr. Fowler thinks that, in the absence of experimental proof, we are for the present justified in regarding the heliciform cavity as due, in those cases where we have no direct evidence, to the same cause as those in which our knowledge is more exact. The anatomy of the colony in the main resembles that of *Rhabdopsammia* already described by the author; the animal is diœcious.

Unlike the rest of the 'Challenger' material, the spirit specimens of *Bathyactis* are histologically useless, due, possibly, to the rapidly diminishing pressure during their sudden ascent from the great depths at which these corals live. *Bathyactis* belongs to the imperforate division, and must not, therefore, be classed with the Fungiidæ, which have been shown by Bourne to be true perforate corals.

* Quart Journ. Micr. Sci., xxx. (1890) pp. 551–63 (1 pl.).
† T. c., pp. 405–19 (1 pl.).

Development of Septa of Halcampa chrysanthellum.*—M. Faurot describes the order of development of the twelve large septa of *Halcampa chrysanthellum* ; they are arranged in pairs, and are fertile in their upper part only. The smaller septa, of which there are twelve also, are all sterile.

Habits and Species of Tubipora.†—Dr. S. J. Hickson sometimes found a lump of *Tubipora* half in and half out of the water; in such cases every stage of contraction may be seen. It is very probable that the power of complete retraction into solid calcareous tubes enables the organ-pipe coral to live in places which are at times left partially dry at low water. The author was forced to conclude that only one true species is to be found at Talisse. The length and diameter of the tubes and the appearance of the horizontal platforms are not the trustworthy specific characters which they have been supposed to be. The length and diameter depend entirely upon the position of the coral on the reef.

Maturation of Ovum and Early Stages in Development of Allopora.‡—Dr. S. J. Hickson finds that, while ova and young embryos are found in the younger branches of the colony, the sperm-morulæ and spermatozoa are only found in the older, thicker branches. As an ovum growing in one of the ordinary canals enlarges it pushes out the endoderm and ectoderm of the canal in which it is formed, and thus makes for itself a diverticulum; at the same time the endoderm of the canal-wall in the immediate neighbourhood of the aperture of the diverticulum becomes thickened, and throws out five radial pouches which embrace the proximal pole of the diverticulum. The five pouches throw out secondary pouches and give rise to a nourishing lenticular mass of cells—the trophodisc. A little later, and after some changes, fertilization probably occurs. The primitive ectoderm arises in the form of a thin membrane of clear protoplasm containing only a few small yolk-spherules which separates from the distal periphery of the young embryo. This ectoderm spreads over the periphery until it entirely incloses the central protoplasm and yolk-mass, and the embryonic ectoderm-cells are formed by the splitting up of the protoplasm into columnar epithelial cells, each of which contains a single nucleus. When the embryo has a complete columnar ectoderm it is ready to escape, but the method by which this is effected has not yet been observed ; probably a channel is formed for it by the absorption of a part of the superjacent calcareous skeleton.

Occurrence of Hydromedusæ and Scyphomedusæ throughout the Year.§—Prof. W. C. M'Intosh gives interesting notes on this subject, as a further contribution from the St. Andrews Marine Laboratory. The Medusæ are of importance to fisheries, owing to the vast number of ova and free planulæ to which they give rise.

Mode of Attachment of Embryos to Oral Arms of Aurelia aurita.‖—Mr. E. A. Minchin, finding that the only descriptions of the brood-capsules of this common Jellyfish—those of Claus and Agassiz—are

* Comptes Rendus, cx. (1890) pp. 249–51.
† 'A Naturalist in North Celebes' (London, 1889) pp. 128–30.
‡ Quart. Journ. Micr. Sci., xxx. (1890) pp. 579–98 (1 pl.).
§ Ann. and Mag. Nat. Hist., v. (1890) pp. 296–306.
‖ Proc. Zool. Soc., 1889 (1890) pp. 583–5 (2 pls.).

erroneous, has drawn up an account of his own observations. On the oral arms there may be seen knobs which are really little stalked capsules or pouches which contain the embryos; these capsules are simply evaginations of the groove of the oral arm, and lined, therefore, internally by endoderm, and externally by ectoderm. In the smaller capsules the walls are relatively thick, and contain a great deal of mesoglœa, while the capsules themselves open by a comparatively wide opening into the lumen of the groove; in the larger capsules the mesoglœa is scarcely visible, and the openings are much narrowed. Embryos in all stages of development up to partly-formed planulæ are to be found. In addition to those contained in the capsules, a large number are always seen lying free in the bottom of the groove or lodged in the foldings of its margin.

Composite Cœnosarcal Tubes of Hydroids.*—Dr. J. C. C. Loman discusses the composite cœnosarcal tubes of *Plumularia halecioides*, *Corydendrium parasiticum*, *Antennularia antennina*, some species of *Tubularia* and *Corymorpha*, but especially those of *Amalthæa vardoensis* n. sp. In *Tubularia* the cœnosarcal tube divides below the stomach into several peripheral branches; so is it with *Corymorpha;* but the others show diverse conditions, and in *Amalthæa vardoensis* there are offshoot canals from three different regions of the tube. In the last-named form, radial vessels proceed from the stomach to the periphery, and open between the tentacles like anal pores in Hydromedusæ. The polype-head is separated from the hydranth-stalk not only by an external depression, but internally as well by a flat annular continuation of the supporting lamella, penetrated by the small opening of the cœnosarcal tube, which at this point gives off branched anastomosing tubules upwards to the head and downwards to the stem. These canals are lined by flat endodermic cells, while the elements which line the above-mentioned radial vessels from the stomach are columnar. The latter are digestive, and perhaps excretory; the former are circulatory. The constriction is regarded by the author as comparable to strobilization, and the species in question is described as a "monodiscal strobila of a hydropolype." It has a markedly medusoid structure, and is defined off from the stalk by an almost closed ring of supporting lamella and by a deep ectodermal groove.

Hydroid Phase of Limnocodium Sowerbyi.†—Dr. G. H. Fowler made, during 1888, some observations on the hydroid phase of *Limnocodium Sowerbyi*, which was first observed by Mr. F. A. Parsons. As neither hydroid nor medusoid could be found during 1889, he now publishes his incomplete observations. The polyp has the form of a simple cylindrical tube about 6 mm. long, has a minute mouth and is always devoid of tentacles; in spite of their absence, it catches and swallows small Crustaceans and free Nematodes. There is no perisarc, and only a loose case of vegetable detritus. The ectoderm is but little differentiated; the nematocysts are, as in *Hydra*, of two kinds. The layer of mesoglœa is so thin as to be practically unrecognizable. The cells of the upper third of the endoderm are highly vacuolated and clear, and pass imperceptibly into those of the lower two-thirds, which are filled

* Tijdschr. Neder. Dierk. Ver., ii. (1889) pp. 263–84 (1 pl. and 5 figs.).
† Quart. Journ. Micr. Sci., xxx. (1890) pp. 507–14 (1 pl.).

with spherical bodies which vary in size and stain very brilliantly. It is from the lower region only that gemmation of a new hydroid takes place, and the endoderm of the hydroid-bud consists only of these cells. As the bud does not develop a mouth for some little time after it is set free, it is possible that the spherical bodies are a store of reserve nutriment. The hydroid-bud only differs from the parent in the uniformly cubical shape of the ectoderm-cells, in the absence of a mouth, of nematocysts and one or two other characters.

Only one specimen was available for the study of the gemmation of the medusoid; in it it was formed at the apex of a polyp. The author gives details as to the few observations he was able to make.

It is to be borne in mind that no free female medusoids have yet been found; it is possible that there is a kind of "male parthenogenesis" comparable to the sporogony discovered by Metschnikoff in certain *Cuninæ*, when the immature sexual cells separated themselves from the generative organs, both in males and females, and began to multiply, one set of cells becoming engulfed by another, and, thus protected, dividing and redividing to form a morula, which under certain circumstances developed into a medusa. No conclusion can yet be certainly come to as to whether this remarkable form should be placed with the Trachymedusæ or the Leptomedusæ.

Trembley's Experiments on Hydra.*—Dr. C. Ischikawa has repeated and extended Trembley's well-known experiments on turning *Hydræ* inside out. He first isolates a specimen in a watch-glass filled with water, fixes it firmly by its hinder end to a small glass rod, and then seizes the anterior end with a forked needle. The operation is very easy, and after a little practice, one can invert a *Hydra* in five or six minutes. Care must be taken that there are no Daphnid-tails in the stomach, as their sharp edges easily destroy the endodermal cells. To try and prevent the creatures returning to their original relation of parts, a bristle was passed through them.

The inverted *Hydræ* will regain their original position if it is in any way possible to them, and if they cannot they die; the bristle does not stop their activity. The return to the original position is often so rapid that it may be easily overlooked unless the creatures are continuously watched. If part of a body of a *Hydra* be cut off, the new head is always developed at the anterior end; this fact is not in accordance with Nussbaum's view that the ectodermal cells of an inverted *Hydra* creep over and cover the endoderm. The intermediate cells are not able to regenerate all the lost cells of the body; they are young ectodermal cells, and as such can only replace the lost ectodermal cells. A small piece of ectoderm completely freed from endoderm is never regenerated into a complete animal; at the same time the intermediate cells of such a piece live and multiply for some time after the operation by budding.

If a *Hydra* attempts to take food which is so large as to extend the mouth too much it turns itself inside out around it, and immediately returns to its original position; this fact is of interest as explaining the possibility of an artificially inverted *Hydra* returning to its original

* Zeitschr. f. Wiss. Zool., xlix. (1889) [1890] pp. 433–60 (3 pls.).

relation of parts. It is possible to bring two animals into a state of permanent fusion if they are attached to one another by means of bristles, or if one is placed in the other.

Evagination of Hydra.*—Herr M. Nussbaum discussing this communication of Herr C. Ischikawa's, remarks on the changes which ensue when a *Hydra* is turned inside out. He restates his old conclusion † that ectoderm does not become endoderm, nor *vice versâ;* on the contrary, the ectoderm along with the middle lamella and with the endoderm as well, grows over the evaginated original endoderm, in a fashion also observed in wound-healing. Complicated processes of coalescence, absorption, and fresh growth restore the polype to its *status quo.* Nussbaum maintains that Ischikawa has only corroborated the above explanation, although he has sought to contradict and correct it.

Initial Cells of Ovary of Freshwater Hydra.‡—M. J. Chatin finds that those observers have been misled who have asserted the presence of free nuclei in the ovary of *Hydra.* When suitable methods, such as the use of solution of dahlia, followed by weak acetic acid, are applied these nuclei are seen to have a delicate layer of protoplasm around them.

Porifera.

Deep-sea Keratosa of the 'Challenger.'§—Prof. E. Haeckel gives an account of some remarkable organisms which have been assigned to various divisions of the animal kingdom. They have been curiously modified by symbiosis with a commensal organism which is very probably in most cases (if not in all) a Hydropolyp stock. Eleven genera and twenty-six species, all of which are new, are described in this report.

Old and new Questions concerning Sponges.‖—Mr. A. Dendy, under the above heading, deals with some problems in the structure of sponges. In answer to Dr. v. Lendenfeld, he does not contend that "Sollas' membrane" is found in all Sponges, but it is most certainly present in *Stelospongus flabelliformis;* while some of Mr. Dendy's figures were diagrammatic, others were as exact representations of actual preparations as he was able to produce. Turning next to Dr. Poléjaeff's statement that we must consider the horny sponges as a palæontologically ancient group, he gives a statement as to his own observations on *Siphonochalina,* in which genus there are three species which nearly resemble one another in external form. *S. spiculosa* has large and very numerous spicules, *S. procumbens* has three distinct and abundant, while *S. ceratosa* has the spicules excessively small and slender, and reduced to the merest vestigial structures imbedded in the stout horny fibres. In *S. plicifera* and *S. maxima* some specimens may sometimes contain vestigial traces while others are entirely destitute of spicules. It is impossible to assert that some horny sponges, at any rate, are not descendants of siliceous Chalininæ.

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 111–20. † Op. c., xxix.
‡ Comptes Rendus, cx. (1890) pp. 414–6.
§ Reports of the Voyage of H.M.S. 'Challenger,' xxxi., Part lxxxii. (1889) 92 pp. and 8 pls. ‖ Zool. Anzeig., xiii. (1890) pp. 14–7.

West Indian Chalinine Sponges.*—Mr. A. Dendy gives an account of the Chalinine fauna of the West Indies; of the eight species described five are new. They are interesting as exhibiting the great variability in external form to which species of sponges living in shallow, or comparatively shallow water are subject, and they illustrate in a very striking way the manner in which the siliceous spicules gradually degenerate and ultimately completely vanish as the horny skeleton becomes more and more strongly developed. This latter point has already been urged by the author and Mr. S. O. Ridley in their 'Challenger' report. From the systematic point of view we are led to the conclusion that it is no longer possible to draw a sharp line of distinction between the Chalininæ and the so-called Keratosa. The immediate cause of the disappearance of the spicules appears to be the development of spongin to such an extent as to form by itself a sufficiently strong skeleton; in such forms spicules would probably be actually harmful as tending to make rigid and brittle fibre that should be elastic and flexible. Spongin appears to develope to a large extent only in warm climates and rather shallow waters.

Development of Siliceous Sponges.†—M. Y. Delage asserts the presence of a special external cellular layer which becomes the ectoderm, and of ciliated cells which represent the endoderm in the larvæ of Siliceous Sponges. This statement disposes of the radical and incomprehensible difference which has been supposed to obtain between Calcareous and Siliceous Sponges. Observations made on the development of *Fissurella* show that the processes of development are fundamentally the same. The larva of this form may be regarded as a *Sycon*-larva which, in place of being empty within, early developed a large amount of mesoderm which filled the whole body; the ectoderm, instead of being confined to the posterior pole, extends, under the form of a layer of separated elements, over the whole of the ciliated region. As a regular invagination is made impossible owing to the presence of a central nucleus the ciliated cells make their way separately, breaking the ranks, so to speak, and later on take up their epithelial position within the interior of the body.

Protozoa.

Terricolous Protozoa.‡—Dr. Maria Sacchi has a preliminary note on terricolous Protozoa. If a little dry earth be placed on a slide, the large grains eliminated, the rest moistened with a drop of distilled water, and the usual cover-glass laid on, there is at first no appearance of life. In a short time, however, there will be signs of diatoms or algæ, and, later on, there may or may not be indications of Rhizopods and Infusorians. Sometimes, and especially when fragments of protozoic tests are seen in the earth, various forms of *Amœbæ* may be easily found. The richest earths are those collected from clefts and angles of walls or roofs; the poorest, compact vegetable humus. The species most frequently found are *Amœba princeps*, *radiosa*, *verrucosa*, *terricola*. Of the last a

* Trans. Zool. Soc. Lond., xii. (1890) pp. 349–68 (6 pls.).
† Comptes Rendus, cx. (1890) pp. 654–7.
‡ Journ. de Microgr., xiv. (1890) pp. 107–9.

number of varieties have been seen. *Arcella vulgaris* is common. *Euglypha reticulata* and various species of *Difflugia* are not rare, but ciliated and flagellate Infusoria are; only a few Monads or *Euglenæ* have been seen. The differences in the comparative abundance of Rhizopods and Infusoria are, however, not difficult to explain.

Protozoa from Cape Horn.*—M. A. Certes describes the Protozoa collected by the 'Romanche' on its expedition to Cape Horn. In his general introduction he notes the interesting fact that dry deposit, gathered in 1883 and exposed for the first time in 1888, contained germs which regained activity when placed in culture solutions. Thus, there appeared *Oikomonas mutabilis*, various monads, a flagellate Infusorian very like *Phacotus lenticularis*, some algæ, *Bacillus amylobacter*, &c. Among the Rhizopods were three new species of *Nebela*, two of *Trinema*, one of *Centropyxis*, two of *Cadium*, and four new Radiolarians.

Nucleus of Loxophyllum meleagris.†—Prof. E. G. Balbiani has closely studied the nucleus of this ciliate infusorian. He finds that it is formed of a varying number of joints or segments, of which there may be twenty or more, which are connected with one another by the enveloping membrane, but have their contents perfectly distinct. These contents consist of one or more nuclear cords which form more or less numerous convolutions, and by an intermediate substance which contains a large number of granules. Observations show that, in certain cases at any rate, the nucleus does, in a state of repose, contain a chromatic filament, or several, which are free and distinct. The nuclear cords present a very fine transverse striation analogous to that which is seen in the nuclei of the cells of the larva of *Chironomus;* this striation is probably due to the alternation of discs of chromatin with layers of achromatic substance. The addition of a weak solution of ammonia causes the nuclear cords to swell and break up into pieces, the axis of which is occupied by a homogeneous chromatic filament, or by a row of chromatic granulations, while the periphery is formed by a pretty thick layer of homogeneous achromatic substance. Nothing comparable to nucleoli was seen in the nucleus, but they are probably represented by the granulations in the nuclear fluid.

Nuclei of Urostyla.‡—Prof. R. S. Bergh describes the nuclei and the hitherto unobserved micronuclei of *Urostyla grandis* and *Urostyla intermedia* n. sp. The former are exceedingly numerous, 200 or so, and seem to be united by fine filaments; the latter number on an average ten, and are in *U. intermedia* smaller, in *U. grandis* larger than the nuclei. Before division, the breadth of the Infusorians increases and the length decreases. As the new contractile vacuole and adoral zone are formed, the distinction between nuclei and micronuclei for a time disappears; the micronuclei are afterwards seen to assume the coil stage so rarely observed in Infusorians, and also a spindle phase before they divide; the nuclei unite in a single mass, of filamentar structure and ribbon-like form, which presently exhibits fragmentation.

* Rec. Mission Sci. du Cap Horn, vi. (1889) pp. 53 (6 pls. and 9 figs.).
† Zool. Anzeig., xiii. (1890) pp. 110–5, 132–6.
‡ Arch. de Biol., ix. (1889) pp. 497–514 (1 pl.).

Bergh emphasizes the fact that the nuclei and micronuclei of Infusorians in their division differ from the nuclei of most cells in the persistence of the achromatic nuclear membrane, and in the absence of the protoplasmic asters which have been observed even in Rhizopods. Where the membrane persists, it is evident that the achromatic filaments of the nuclear spindle cannot be of external cytoplasmic origin.

Freshwater Heliozoa.*—Dr. E. Pénard, in the second part of his memoir,† continues his account of *Actinophrys sol.* Describing the liberation of an example which had been encysted during the winter, he says that in a cyst about to open there may be observed passing from the centre to the circumference a central grey matter; this was mucilaginous and generally surrounded a circular spot, which, no doubt, represents the nucleus. More externally there is a wide ring of very small granulations, bordered by a zone of limpid plasma, without any contractile vesicle. This last zone is bounded by the internal cyst, which is delicate and extensile, and this again is separated from the external cyst by a mucilaginous material, similar to that which is found within it. The internal cyst always remains spherical, the outer generally elongates, and its ovoid form appears to be due to the powerful endosmosis which is going on. After a time it yields to the pressure within. The internal cyst distends, bursts, and is sometimes carried away. The mucilaginous liquid which surrounds the animal passes gradually to one pole, whence it slowly extends to the right and left, until at last it forms a zone of a clear grey limpid material, which soon becomes hollowed out by small vacuoles, and commences to form the ectosarc. Some of the neighbouring vacuoles increase in size, and by the loss of the partitions which divide them form a contractile vesicle.

Some hours after the emergence of the animal, the pseudopodia are distinctly visible; they exactly resemble the pseudopodia of *Ciliophrys*, a form to which the whole animal may now be compared. In most specimens a well-marked, central, spherical nucleus was seen, but in some cases it could not be detected. The vacuoles of the ectosarc continue to exhibit differentiation, the contractile vesicle increases in size, the pseudopodia grow larger, and, in twenty-four hours, the young *Actinophrys* only differs from the adult by its smaller size. It is probable that, at this stage, it increases by fission.

A detailed description is given of *Acanthocystis pectinata* sp. n. from Wiesbaden; *A. erinaceus* and *A. albida* spp. nn. are more shortly discussed. *Ciliophrys cærulea* sp. n. is also fully described. Some notes on these forms have already appeared in another memoir.‡

Myxosporidia.§—M. P. Thélohan has recently made observations on the Myxosporidia. These interesting organisms consist essentially of a mass of protoplasm in which are formed at a certain period reproductive bodies or spores. They are distinguished from other Sporozoa by two principal characters, namely the structural complexity which their spores may attain, and the fact that the formation of these spores does not mark the termination of the evolutionary cycle of the organism, but

* Arch. de Biol., ix. (1889) pp. 419–72 (3 pls.).
† See this Journal, *ante*, p. 50. ‡ See this Journal, *ante*, p. 193.
§ Annales de Microgr., ii. (1890) pp. 193–213 (18 figs.).

commences quite early and continues during its development. Like all the Sporozoa the Myxosporidia are parasites.

They have been found in a few Invertebrata and in certain Batrachia, but most frequently in fishes. They present themselves under two different conditions, as free mobile amœboid masses, and as more or less voluminous cysts. The free form is found usually in natural cavities (bladder, renal tubules, liver, spleen, ovary, &c.) while the encysted form is most frequently observed in the subcutaneous connective tissue, and the subepithelium of the branchiæ.

According to the author, the spores are ovoid or fusiform in shape, and of two kinds one is small, ovoid, and without polar capsules; the other is larger, encapsulated, possesses two polar bodies, a mass of protoplasm, a vacuole, and also a nucleus. The capsule, which is extremely resistant to reagents, is stainable with safranin, and possesses at its small end an aperture that serves for the exit of a filament.

In technique the author followed the lead of M. Henneguy. The best fixatives were found to be Perenyi's and Flemming's fluids. The paraffin-imbedded sections were fixed to the slide with Mayer's albumen, and then washed in xylol and absolute alcohol. After this they were stained, safranin, borax-carmine, and picrocarmine, followed by gentian-violet (Gram's or Bizzozero's method), giving the best result. Spores, obtained by teasing out, were best treated with osmic acid and methyl-green.

The Genus Didymophyes.*—Dr. P. Mingazzini maintains the inaccuracy of the general opinion which regards *Didymophyes* as two individuals. In the young stage *Didymophyes* is a single-celled Gregarine, and the individual which unites with another posteriorly loses its individuality and becomes simply a metamere. In the union, the head is lost by fusion with the deutomerite. Encystation is preceded by a shortening and broadening of the conjugated cells, and the cysts show no nucleus.

* Atti R. Accad. Lincei—Rend., v. (1889) pp. 365–8 (4 figs.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.

(1) Cell-structure and Protoplasm.

Encasing of Protoplasm.*—Herr G. Haberlandt describes the process of "encasing" (Einkapselung) of the protoplasm in the hairs of various Cucurbitaceæ.

In the short stiff hairs on older leaves of *Bryonia* the protoplasm is frequently divided into two parts of nearly equal size by the secondary thickening of the cell-wall; one-half of the mass of protoplasm contains the nucleus, while the other is destitute of nucleus. If the formation of cellulose-wall proceeds, only that portion of the protoplasm which contains the nucleus forms new cell-walls. If the secondary ring of cellulose becomes only so thick that the protoplasm is merely deeply constricted, then again it is only the half of the protoplasm that contains the nucleus which becomes encased, the first cellulose-cap passing through the narrow piece which unites the two halves. Even when the free outer wall of the hair-cell is uniformly thickened, a division of the protoplasm may take place into two usually unequal halves, the portion which contains the nucleus becoming invested by a number of caps, one within another, as Krabbe has described in the bast-cells of the Asclepiadeæ and Apocynaceæ.†

A similar phenomenon is presented by the hairs on the under side of the leaves of *Sicyos angulatus* and *Momordica Elaterium*. The encasing does not depend on the size of that portion of the protoplasm, but entirely on the presence of the nucleus. The phenomenon differs only from that mentioned above in bast-cells in the latter containing several nuclei, each of which becomes invested with cellulose.

Aggregation of Protoplasm.‡—Herr T. Bokorny has confirmed Darwin's statements as to the aggregation of protoplasm in the tentacles of *Drosera* by a very minute quantity of ammonia, obtaining similar results in a large number of different plants. The phenomena may be of four kinds:—contraction of the entire protoplasm; contraction and division of the vacuole-wall alone; aggregation of the protoplasmic albumen, i. e. excretion of granules of albumen from the cell-sap; or aggregation of the albumen which is sometimes contained in the vacuole-fluid. The plants and parts of plants in which these phenomena were observed are:—*Spirogyra*, tentacles of *Drosera rotundifolia* and *dichotoma*, petals of *Tulipa suaveolens*, epidermal cells of the leaf-stalk or flower-stalk of *Primula sinensis*, stigma of *Crocus vernus*, hypodermal cells of the leaves of *Cotyledon coccinea*, epidermal cells of the pitcher of *Nepenthes phyllamphora*, *Darlingtonia californica*, and *Sarracenia purpurea*, glandular hairs of *Pelargonium*, epidermal cells of the leaf of

* SB. Akad. Wiss. Wien, xcviii. (1889) 10 pp. and 1 pl. See Bot. Centralbl., xl. (1889) p. 144.

† Cf. this Journal, 1888, p. 441.

‡ Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 427–74 (1 pl.).

Dionæa muscipula, &c. The amount of ammonia required to produce this result is inconceivably small; in *Spirogyra* it is brought about by a solution of 1 in 10,000. Other alkaline reagents produce similar results; caffeine is especially to be recommended. All the phenomena appear to depend on a transition of the albumen of the living cell, which is in a turgescent condition, into a denser condition caused by traces of alkaline substances.

Composition of the Cell-wall.*—According to Herren Schulze, Steiger, and Maxwell, many other carbohydrates besides cellulose enter into the composition of the cell-wall. They propose to limit the term cellulose to that constituent which is only slightly attacked by very dilute mineral acids, is soluble in ammonium-copper oxide, is coloured blue by chlor-zinc iodide or iodized sulphuric acid, and which yields dextrose on saccharosis by strong sulphuric acid. The other carbohydrates differ considerably in their properties from cellulose. They appear to be insoluble in ammonium-copper oxide, and some of them yield a cherry-red fluid on warming with phloroglucin and hydrochloric acid, they are rapidly saccharized by dilute mineral acids which scarcely affect cellulose, yielding galactose, mannose, and pentaglycoses.

The authors propose for these the designation "paragalactan-like substances"; paragalactan (or paragalactin) itself, the result of heating galactose with sulphuric acid, has been obtained by them from the seeds of *Lupinus luteus*. These substances appear to enter much more readily into the soluble condition than cellulose, as, for example, in the process of germination; paragalactan is a reserve-substance in the seeds of the lupin, and it is doubtful whether true cellulose ever serves this purpose.

History of Cell-theories.†—Herr R. Altmann gives a brief *résumé* of the various theories propounded as to the constitution of the cell. He considers the animal to be far more favourable than the vegetable cell for the solution of problems as to its true nature. His general conclusions are that there is no uniform sarcode, but only a polymerous protoplasm, and that the cell is not an elementary structure, but a colony of such structures.

(2). Other Cell-contents (including Secretions).

Deposition of Starch in Woody Plants.‡—According to M. E. Wotczal, the resorption of starch in tissues when the active period of vegetation commences, begins at two opposite spots—in the youngest branches, and in the youngest roots, and proceeds from these towards the older parts in two opposite waves. But between these, in the oldest parts between stem and root, a considerable portion of reserve-starch remains unconsumed. The deposition of newly-formed starch also takes place in two opposite waves, in the reverse direction to its absorption.

* Zeitschr. f. Physiol. Chemie, xiv. (1889) pp. 227–73. See Bot. Centralbl., xli. (1890) p. 181.

† 'Zur Geschichte d. Zelltheorieen,' Leipzig, 1889, 8vo, 20 pp. See Bot. Centralbl., xli. (1890) p. 183.

‡ Arb. Naturf.-Ver. Kasan, 1888, 6 pp. (Russian). See Bot. Centralbl., xli. (1890) p. 99.

Aleurone-grains.*—Herr T. Lüdtke discusses these bodies from the following points of view:—(1) Behaviour towards reagents; (2) comparative investigation of their morphological characters; (3) the changes induced in them by the swelling of seeds in water; (4) their development in the ripening of seeds; (5) their absorption in the germination of seeds. In a fully developed aleurone-grain the following parts are to be distinguished:—(1) The membrane; (2) the ground-substance (matrix); (3) the inclosed substances, consisting of protein-crystalloids, globoids, and crystals of calcium oxalate.

Under the second head the author distinguishes the following four types:—(1) *Gramineæ-type;* grains small, without inclosed substances or globoids (Gramineæ, Cyperaceæ); (2) *Leguminosæ-type;* larger or smaller grains containing globoids (Papilionaceæ, Cæsalpinieæ, Cruciferæ, Ranunculaceæ, Liliaceæ, &c.); (3) *Umbelliferæ-type;* grains larger (5–11 μ), containing globoids or crystals (Umbelliferæ, Compositæ, &c.); (4) *Euphorbiaceæ-type;* grains of the most perfect development (Coniferæ, Palmæ, Euphorbiaceæ, Solanaceæ, Labiatæ, &c.).

Those aleurone-grains which contain no inclosures except globoids resist the action of water better than those which contain crystals. The formation of crystalloids and globoids is, according to the author, not a physico-chemical process, for all the inclosed substances are formed by the vital activity of the cell. The mode of absorption of the aleurone-grains on germination differs in different seeds, and is described in detail in a number of examples.

Carotin.†—Herr H. Immendorff finds carotin to be a normal and constant product of vegetable life, and to be always present in leaves. He gives it the formula $C_{26}H_{38}$. The mode of extracting this substance is given in detail, and the author states that it is the only yellow or yellow-red constituent of normal chlorophyll. He finds it also in etiolated leaves, and in those which have assumed their autumn tint.

M. Arnaud ‡ gives the percentage of carotin found by analysis in a number of plants. It varies with the species and with the period of growth, generally increasing up to the time of flowering, and then diminishing gradually until the fall of the leaves. According to this author, it always accompanies chlorophyll in the leaves; and, like chlorophyll, has a tendency to disappear in the dark.

Solanine.§—M. E. Wotczal gives the following as the only trustworthy microchemical tests for solanine, viz. (1) Mandalin's vanadin-sulphuric acid, i.e. 1 part of ammonia meta-vanadinate in 1000 parts of trihydrate of sulphuric acid; (2) Brandt's reagent, i.e. 3 grains of sodium selenate in a mixture of 8 ccm. of water and 6 ccm. of pure sulphuric acid; and (3) pure sulphuric acid. The first is especially a test of extraordinary delicacy; and the series of changes of colour which it brings out in a preparation containing solanine is described in detail.

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 282–90, and Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 62–127 (3 pls.).

† Landwirtsch. Jahrb., xviii. (1889) pp. 506–20. See Bot. Centralbl. xli. (1890) p. 210. ‡ Comptes Rendus, cix. (1889) pp. 911–4. Cf. this Journal, 1887, p. 983.

§ Arb. Naturf.-Ver. Kasan, xviii. (1888) 103 pp.; xix. (1889) 74 pp. (Russian). See Bot. Centralbl., xli. (1890) p. 100.

Solanine was found in nine species of *Solanum* and three of *Scopolia*. In the vegetative organs it occurs in greatest abundance in the young tissues, and in the mature parts is usually entirely absent. In the floral organs, on the other hand, it continues to increase up to a certain period, and is especially abundant in the peripheral layers of the unripe fruit. Its seat is in the cell-cavity, where it occurs in the form of a soluble salt, and from which it penetrates also to the cell-wall.

The author regards solanine as a product neither of primary synthesis nor of disorganization, nor as a secretion or excretion, nor as a reserve-substance, nor as a transporting form like asparagin, but as an intermediate stage in the series of chemical changes which already-formed plastic substances undergo in the living cell. In the flowers and unripe fruits it undoubtedly also serves as a protection against consumption by animals.

Allium-Oil.*—Herr A. Voigt finds allium-oil or allyl-sulphide $[C_3H_5]_2S$ as an ethereal oil in all parts of various species of *Allium*, viz. in the stem, leaves, bulb-scales; both in the epiderm and the bundle-sheath, viz. in the bundle-sheath of the floral organs; in the outer endoderm and root-cap, in the root, the fruit, and the integument of the seeds; in the layer of the endosperm immediately surrounding the embryo. It is present at all periods of growth, and has apparently been formed in the process of metastasis. The author regards its physiological purpose to be mainly as a protection against the attacks of animals; but its presence in the vascular bundle-sheath also serves to secure a path for the conduction of water and plasmic substances.

Amount and Composition of Ash.†—Prof. C. Councler gives particulars of the proportion of ash found in the dried material from a number of herbaceous and woody plants, the amount varying from 15·35 p. c. in *Adonis æstivalis*, to 1·35 p. c. in the pine, and as low as 1·08 p. c. in branches of the same tree on which the mistletoe was parasitic, the mistletoe itself containing, in different organs, from 3·49 to 8·11 p. c. of ash. The percentage composition of the ash is also given in the different species; the mistletoe withdraws from its host especially large quantities of potassium salts and phosphates.

(3) Structure of Tissues.

Liber of Angiosperms.‡—M. H. Lecomte has made an exhaustive examination of the structure and development of the liber in the stem and leaves of the vine, lime, gourd, and many other woody and herbaceous plants. The following are the more important results:—

The liber of Angiosperms comprises two classes of elements—the essential (sieve-tubes and companion-cells) and the accessory elements (liber-parenchyme, sclerotized cells, and liber-fibres). The fibres surrounded by liber almost always differ in their histological and microchemical properties from those of the fibre outside the liber. The liber-parenchyme is often composed of elongated cells (fibres), simple or

* 'Lokalisirung d. æther. Oeles in d. Geweben d. *Allium*-Arten,' Hamburg, 1889, 8vo, 18 pp. See Bot. Centralbl., xli. (1890) p. 292.

† Bot. Centralbl., xl. (1889) pp. 97–100, 129–33.

‡ Ann. Sci. Nat. (Bot.), x. (1889) pp. 193–324 (4 pls.).

with transverse septa. The secreting canals of the liber never abut on sieve-tubes. The sieve-tubes of Angiosperms are dispersed irregularly through the primary liber. There are two distinct types of sieve-tube, those of the gourd and of the vine; but all intermediate forms may occur in the same plant. The elements separated from the sieve-tubes by tangential walls must be considered, like those separated by radial or oblique walls, as companion-cells. Besides the sieve-plates on their terminal walls, the sieve-tubes may have others, usually smaller, on their longitudinal walls. The liber-fibres may be united transversely by series of sieve-cells developed in the medullary rays. The formation of callus is due to excessive development of the thin layer of the membrane which covers the filaments of cellulose. The nucleus of the sieve-tubes usually disappears at an early period, but may sometimes be found in the parietal protoplasm of still active tubes. The contents of a sieve-tube in its active state consist of a thin layer of active parietal protoplasm, and a large central vacuole containing water and albuminoid substances in solution. The companion-cells also contain abundance of albuminoids, but neither they nor the sieve-tubes contain starch. The duration of activity of the sieve-tubes varies greatly, as also does the period of the appearance of the callus. Seedlings of the gourd kept in the dark developed abundant callus in the liber of the hypocotyl (tigellum); while those exposed to full light had their sieve-plates perforated.

Collenchymatous Cork.*—Herr H. Molisch describes a tissue of a peculiar character which he finds immediately beneath the epiderm of the fruit in several varieties of *Capsicum*. It partakes of the very different characters of cork and collenchyme, resembling ordinary parenchymatous collenchyme in its appearance, contents, and mode of thickening, but presents none of the characteristic reactions of cellulose, being, on the other hand, strongly suberized. It is two or three layers of cells in thickness, and of a golden-yellow colour.

Thyllæ.†—Herr H. Conwentz describes the structure and mode of formation of thyllæ or similar structures, especially in the wood of those fossil trees which produce amber, where they occur exclusively in the root. Their structure here is the same as that in existing plants, where they are sometimes characteristic of entire natural orders, sometimes of particular genera. They result from the growth of the closing membrane of the bordered pits which lie on the common wall of a tracheid or vessel and of a parenchyme-cell. Similar structures are found also in resin-canals, as the results of the growth of the epithele-cells into the intercellular spaces. They may also be the result of injury. A thylla has always the same physiological purpose, viz. to cut off an organ which is no longer performing its function.

Secondary Vascular Bundles of the Arborescent Liliaceæ.‡—Dr. P. Röseler gives further arguments in favour of his contention that in the arborescent Liliaceæ every rudiment of a vascular bundle

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 364–6.
† T. c., Gen.-Versamml.-Heft, pp. 34–40. Cf. this Journal, 1888, p. 988.
‡ Bot. Ztg., xlviii. (1890) pp. 26–30. Cf. this Journal, 1889, p. 657.

contains young tracheïds from a length only slightly exceeding the height of the meristem-cells to that of fully developed tracheïds; that each young tracheïd contains only a single nucleus; and that the fully-developed tracheïds have a minimum length about ten times the height of the meristem-cells.

Intraxylary Phloem.*—Dr. Solereder has examined the anatomical structure of a number of species of Thymelæaceæ and Penæaceæ in which bicollateral vascular bundles occur, and finds intraxylary phloem to be a constant character for these families.

Stem of Compositæ.†—According to Herr Schumann, there occur in some Compositæ, as, e. g. in *Carlina acaulis*, vascular bundles which are limited in growth in consequence of being completely surrounded by a sheath of bast-fibres or similar elements, resembling wood-fibres in their form and in the nature of their walls, except that these are thicker and not so copiously pitted as in wood-fibres; no transitional forms occur except in some Cardueæ. The bast-fibres of Compositæ are almost always septated. Secondary medullary rays are scarcely ever found, except in *Solidago longifolia*, where there are a very few. The primary medullary rays are usually composed of lignified fundamental cells. The continuous ring of wood is generally very wavy. The pitting of the wood-fibres is always strongest on the tangential walls; on the radial walls it is occasionally altogether wanting. The pith is distinguished by the thinness of its walls, though occasionally a few of its cells are sclerotized. The cambium-ring is often very greatly reduced in size.

Supporting-bundles in the Stem of Cichoriaceæ.‡—From an examination of various stages of development, Dr. O. Kruch has arrived at the conclusion that the importance attributed by Van Tieghem and Morot to the pericycle is not exhibited in the case under consideration. He believes that in the stem, branches, and leaf-stalks of Ligulifloræ we have no system of sustaining bundles belonging to the pericycle, but, on the other hand, a system of mechanical cords of procambial character belonging to the sieve-portion of the vascular bundles.

Bark of Leaf-stalks.§—M. L. Morot points out that in the leaf-stalk of certain species of Simarubiaceæ and Sapindaceæ the bark derives its origin from the hypodermal layer of cells, the bark itself sometimes consisting of as many as six or eight layers.

Constituents of Lignin.‖—Herr G. Lange has subjected beech-wood and oak-wood to very careful analysis, after removing all impurities by water, 5 per cent. hydrochloric acid, alcohol, ether, ammonia, and soda-lye, and then exposing for a long period to the action of caustic potash at a temperature of 185° C., for the purpose of separating the cellulose from the lignic acids. In addition to the cellulose a substance was found soluble in alkalies, which could be separated by alcohol into two lignic acids.

* SB. Bot. Ver. München, Jan. 13, 1890. See Bot. Centralbl., xli. (1890) p. 250.
† Bot. Centralbl., xli. (1890) pp. 193-6. ‡ Malpighia, iii. (1889) pp. 358–66.
§ Journ. de Bot. (Morot), iii. (1889) pp. 407–8.
‖ Zeitschr. f. Physiol. Chemie, xiv. pp. 15–31. See Bot. Centralbl., xli. (1890) p. 23.

Structure of Loasaceæ.*—Herr R. Racine describes the histological structure of the wood of this natural order of plants, which differs in some respects from the nearly allied Cucurbitaceæ. The cambium-ring is closed, and displays only limited increase in thickness; the vascular bundles are arranged in a single circle, and are collateral in structure; the number of bundles is almost always twelve. The development of the flowers is also described.

Dioscoreaceæ.†—Herr E. Bucherer describes the anatomical and histological characters of this natural order, especially in reference to the genera *Dioscorea* and *Tamus*. The structure is described in detail of the tuber, the stem and the root, special attention being paid to the differences in the distribution and structure of the vascular bundles in the tuber and in the stem. Tubers occur in *Dioscorea sinuata*, *D. Batatas*, *Tamus elephantipes*, and *T. communis*.

(4) Structure of Organs.

Monochasia.‡—Dr. K. Schumann describes various instances of this mode of inflorescence, especially those occurring in the genus *Corchorus*. He defines a monochasium as a system of shoots in which the axis of the first order is closed, and the axis of the second order takes up its continuation; the continuation of this being again taken up by the axis of the third order, and so on. Since there is no possibility of a transition between an axis of the first and one of the second order, every shoot-system, at least in the case of flowering plants with closed buds, must be either a monopodium or a sympodium.

Pickerel-weed Pollen.§—Prof. B. D. Halsted describes the pollen of the pickerel-weed (*Pontederia cordata*). It is trimorphic, and the relative size of the pollen-grains in the three forms corresponds to the relative length of the styles. The difference in size between the largest and the smallest grains is the greatest yet described for any flower, being about 8:1.

Phylogeny of Amentaceæ.‖—Dr. L. Celakovsky discusses the phylogenetic development of the different families of Amentaceæ. The differences are the result of reduction, both in the vegetative and the reproductive organs. As respects the former, the lower portion of the lateral shoots is reduced, and the shoots become purely reproductive; and this reduction attains a higher degree when the upper reproductive portion of the main shoots is also reduced, and uniaxial or monocaulic plants become biaxial or diplocaulic. Reduction of the reproductive organs is shown by the hermaphrodite flowers becoming either male or female.

Four stages can be distinguished in the phylogenetic development of the Amentaceæ, viz.:—(1) The fertile shoots are all alike, and the flowers hermaphrodite (prehistoric); (2) the foliage-leaves are rudi-

* 'Zur Kenntniss d. Blütenentwickelung u. d. Gefässbündelverlaufes d. Loasaceen,' Rostock, 1889, 8vo, 46 pp. and 1 pl. See Bot. Centralbl., xl. (1889) p. 392.
† Haenlein u. Luerssen's Biblioth. Bot., Heft 16, 35 pp. and 5 pls.
‡ SB. K. Preuss. Akad. Wiss., xxix. (1889) pp. 555–84 (1 pl.).
§ Bot. Gazette, xiv. (1889) pp. 255–7 (1 fig.).
‖ SB. K. Böhm. Gesell. Wiss., 1889, pp. 319–43 (1 pl.) (German résumé).

mentary or altogether suppressed on the lateral shoots; the main shoot is altogether barren; the flowers are unisexual but monœcious (*Nothofagus*); (3) the foliage-leaves which subtend the fertile shoots are metamorphosed into bracts, and the inflorescence becomes a catkin, which is either bisexual (*Platycarya*) or more often unisexual (Betulaceæ, most Juglandeæ); (4) further reduction has taken place; some of the reproductive shoots are replaced by vegetative resting-buds (*Castanea*); the female inflorescences are greatly reduced and inclosed in a cupule (Cupuliferæ).

Pericarp of the Barley-grain.*—Dr. A. Zoebl gives an exhaustive description of the anatomy and histology of the integument or pericarp of the grain of *Hordeum distichum* and of the pales, chiefly from the point of view of its commercial value. The points specially described are the epiderm, the parenchyme of the pales, the awn, the layers of tissue of the pericarp itself, and the hairs on the pericarp. The author speaks of the walls of the epiderm of the pales which abut on those of the fibre-cells as being especially characterized by their abundant and strongly-developed pits.

Integument of the Seed in Geraniaceæ, Lythraceæ, and Oenothereæ.†—M. M. Brandza states that it is generally admitted that during the evolution of the ovule into the seed, the nucellus and inner integument of the ovule are absorbed by the embryo; Euphorbiaceæ, Rosaceæ and Rutaceæ being exceptions. The author, however, to test this, has chosen three distinct families of plants, and his conclusions are as follows:—(1) In the Geraniaceæ the integuments of the ovule persist, and give rise to the corresponding parts of the integument of the seed. (2) In the Oenothereæ and Lythraceæ it is the same, but the outermost layers of the nucellus also persist.

Extrafloral Nectaries.‡—Prof. F. Delpino describes the excretion of nectar from the under side of the six or seven leaves which for the time being are the uppermost on the stem of *Helianthus giganteus* and *H. tuberosus;* and a similar phenomenon, hitherto undetected, on the under side of the upper leaves of *Glycine sinensis* (Papilionaceæ). The involucral scales of *Centaurea montana* also exude an abundance of a nectariferous fluid. In all these cases the object of the extrafloral nectaries is the attraction of ants and other insects which feed greedily on the sweet fluid, and the consequent protection of the flowers.

Temporary Ascidia in Sterculia.§—Prof. F. Delpino describes the peculiar development of the pistil of *Sterculia platanifolia* after fertilization, by which the carpids separate from one another, and each swells up into a bladder of considerable size. These bladders are temporary ascidia, filled with a noisome fluid, and covered on the inner surface with multitudes of multicellular glandular hairs. The author believes these structures to have a similar purpose to the calycine ascidia described by Treub ‖ in *Spathodea campanulata*, and to perform a double function

* Abhandl. Naturf. Ver. Brünn, 1888 (1889) pp. 205–28 (20 figs.).
† Bull. Soc. Bot. France, xxxvi. (1889) pp. 417–20.
‡ Malpighia, iii. (1889) pp. 344–7. Cf. this Journal, *ante*, p 201.
§ Malpighia, iii. (1889) pp. 339–44. ‖ Cf. this Journal, 1889, p. 86.

—a digestive function and one of protecting the seeds while in the process of development from injury by ovipositing insects.

Alocasia macrorrhiza and some other Aroideæ present a somewhat similar structure in the lower part of the spathe.

Phyllodes.*—Prof. G. L. Goodale proposes to extend the use of the term phyllode, in accordance with the practice of some, but not of all writers, to all flattened petioles where there is a great reduction or entire abortion of the lamina, whether the surface of the petiole be horizontal or vertical. The so-called phyllodes of some species of *Eucalyptus* are true leaves, the lamina of which has assumed a vertical position from a twist of the leaf-stalk. Prof. Goodale suggests that the vertical position, whether of phyllode or of lamina, may be regarded as a permanent sleep-position, occurring only in shrubs or trees growing in very exposed situations or in a very dry climate, and serving to protect the foliage from excessive radiation.

Bracts.†—From a comparative examination of the bracts of plants belonging to a large number of different families, Herr F. Schmidt comes to the conclusion that they do not form a single morphological group, but are sometimes laminæ of leaves, with or without petiole, sometimes leaf-sheaths, sometimes stipules, sometimes of no definite morphological character. From a physiological point of view they are leaves which subtend flowers, and are designed either as protecting organs, or to co-operate with the petals, or as organs for the protection or the dissemination of the fruit. Bracts may be divided morphologically into two groups—those belonging to plants the leaves of which have neither leaf-sheath nor stipule, and those in which the leaves possess one or other of these accessory organs. In the first category the bracts correspond to the sheath or stipule, in the second to the lamina of the leaf.

Foliar Verticels of Spergula.‡—M. W. Russell describes the arrangement of the leaves in *Spergula arvensis*, and states that the leaves are really opposite, but the presence at their axes of short leafy branches gives them a verticillate appearance.

Anatomy of Bud-scales. §—Dr. C. R. G. Schumann gives a general account of the structure of the bud-scales in Conifers and woody Dicotyledons. They serve a double purpose—as a protection to young buds against external injury, and as a contrivance for mechanical strengthening. For the latter purpose they are often strongly cuticularized, and contain collenchymatous and sclerenchymatous elements; the latter, in the cases of *Camellia* and *Magnolia*, in the form of numerous "stone-cells." They are usually entirely destitute of stomates. Their number and thickness vary greatly, the former from four in *Sorbus aucuparia* to as many as 350 in *Pinus austriaca*. Their æstivation or relative position with respect to one another is also very variable. In some bulbs, as, for example, those of South American species of *Oxalis*, the outer scales are modified so as to serve the purpose of bud-scales,

* Amer. Journ. Sci., xxxviii. (1889) pp. 495–7.
† 'Beitr. z. Kenntniss d. Hochblätter,' Berlin, 1889, 4to, 28 pp. and 2 pls. See Bot. Centralbl., xli. (1890) p. 185.
‡ Bull. Soc. Bot. France, xxxvi. (1889) pp. 424–5.
§ Haenlein u. Luerssen's Biblioth. Bot., Heft 15, 1889, 36 pp. and 5 pls.

becoming protective organs, and losing their property of storing up reserve food-materials.

Tubercles on the Roots of Leguminous Plants.*—Prof. H. M. Ward draws attention to some results of further investigation into this subject. In some of the cultures made in the summer of 1888, the roots of the pea were infected with bacteroids from the tubercles of the bean, and this is a point of some importance in view of the belief that each species of Leguminosæ may have its own species of bacteroid. Extracts of the tubercles containing infected germs were made; and although the latter were taken from the tubercles of the bean, they infected the root-hairs of both peas and beans equally well. It is especially the young root-hairs, with extremely delicate cell-walls, that are infected, and the first sign is the appearance of a very brilliant colourless spot in the substance of the cell-wall; sometimes this spot is common to two cell-walls of root-hairs in contact, and not unfrequently several root-hairs are found all fastened together at the common point of infection. This highly refringent spot is obviously the "bright spot" referred to in a previous paper as the point of infection from which the infecting filament takes origin. It soon grows larger and developes a long tubular process, which grows down inside the root-hair and invades the cortex, passing from cell to cell. The "bright spot" is, therefore, the point of origin of the infecting filament, and, as a matter of inference from the experiments, it cannot but be developed from one of the "bacteroids" or "gemmules" of the tubercles.

The author then describes a series of water-cultures of beans infected artificially by placing the contents of tubercles on their root-hairs. These experiments have led the author to conclude that the organism which induces the development of the tubercles is so closely adapted to its conditions that comparatively slight disturbances of the conditions of symbiosis affect its well-being. It is so dependent on the roots of the Leguminosæ that anything which affects their well-being affects it also.

Some experiments with peas were also made as to the alleged connection between the development of the tubercles and the increase of nitrogen in leguminous plants, the evidence all going to show that the leguminous plant gains nitrogen by absorbing the nitrogenous substance of the bacteroids from the tubercles.

The author then compares the conclusion arrived at by Prazmowski † with his own. As to the occurrence, origin, and structure of the tubercles, they are in accordance; but there is one point of difference of extreme importance between Beyerinck and Prazmowski on the one hand, and the author on the other hand, and that is on the subject of the cultivation of the "bacterium" in nutritive media outside the host-plant—or rather the other symbiont.

Use of Anatomical Characters in the Classification of Plants.‡—M. J. Vesque gives a number of examples of the use of anatomical and

* Proc. Roy. Soc., xlvi. (1889) pp. 431–3 (1 fig.). Cf. this Journal, 1888, p. 251.
† Cf. this Journal, *ante*, p. 59.
‡ Bull. Soc. Bot. France, xxxvi. (1889) Actes du Congrès de Bot., pp. xli.–lxxvii. (5 figs.).

morphological characters in the classification of plants, in relation to the following organs:—(1) The organs of reproduction:—pollen, stigmatic papillæ, integument of the ovule and seed, endosperm and embryo; (2) The vegetative organs:—size of the cells, epiderm, hairs, stomates, crystals of calcium oxalate, laticiferous and other internal secreting organs, structure and arrangement of the vascular bundles, palisade and spongy parenchyme, sclereïds, mechanical system, &c.

β. Physiology.

(1) Reproduction and Germination.

Morphological Phenomena of Fertilization.*—M. L. Guignard sums up the conclusions of previous observers on the morphological phenomena on which depends the impregnation of the oosphere in flowering plants. His observations were made chiefly on *Lilium Martagon*, with which are compared the phenomena in *Fritillaria*, *Tulipa*, *Muscaria*, *Agraphis*, *Iris*, *Alstrœmeria*, *Aconitum*, *Delphinium*, *Clematis*, and *Viola*, and the results obtained by Van Beneden † with *Ascaris megalocephala*.

His general conclusions are in harmony with those of Strasburger rather than with those of Van Beneden, viz. that an actual coalescence of the male and female elements, and not merely their coexistence in the oosphere, is necessary to impregnation; a fusion of the nuclear cavities being apparently essential. In the fusion of the two polar nuclei to form the secondary vegetative nucleus of the embryo-sac, these two nuclei may remain distinguishable from one another, and invested each by its own delicate membrane, until the period of the commencement of cell-division, which may not take place until some days after the entrance of the pollen-tube into the embryo-sac. He finds the number of chromatic segments to be the same in the male and female nuclei, and the double number, viz. 24, is always to be detected after impregnation. In the process of division of the nuclei of the endosperm, resulting from the repeated division of the secondary nucleus of the embryo-sac, the number of chromatic segments varies considerably.

When the original nucleus of the pollen-grain divides to produce the vegetative and reproductive nucleus of the pollen-tube, and when the reproductive nucleus again subsequently divides into two, the number of chromatic segments in the two is again the same, but the cytoplasm is distributed unequally in these two new cells, and its microchemical reactions are not alike. The formation of the generative nuclei, comparable to that of the pronuclei in animals, always takes place by the longitudinal doubling of the chromatic segments. The preliminary phenomena which take place within the embryo-sac differ in a remarkable point from those which take place within the pollen-grain. In *Lilium* and probably in other plants also, the two tetrads which result from the bipartition of the primary nucleus of the embryo-sac, and which occupy the two extremities of the sac, present an important difference, which is transmitted to their derivatives. Each of the nuclei of the apical tetrad has always twelve chromatic segments, like the primary nucleus, while each of the nuclei of the basal tetrad has a larger and variable number.

* Bull. Soc. Bot. France, xxxvi. (1889), Actes du Congrès de Bot., pp. c.–cxlvi. (4 pls.), and Comptes Rendus, cx. (1890) pp. 590–2.

† Cf. this Journal, 1888, p. 423.

On the entrance of the pollen-tube into the embryo-sac, the male and female nuclei appear to exert an attractive influence on one another, dependent probably on chemical causes, similar to that which seems to guide the antherozoids of Cryptogams towards the archegone.

Embryo-sac of Compositæ.*—Herr F. Hegelmaier describes the peculiarities in the structure and development of the embryo-sac in some species of Compositæ, especially some belonging to the tribe Heliantheæ. In *Helianthus annuus*, at the time of the opening of the corolla and separation of the arms of the style, the innermost layer of cells of the thick integument has the form of a compact sheath; the elongated cavity becomes filled up by the embryo-sac, with the exception of a small space lying between its own membrane and the inclosing sheath, and caused by the disappearance of the innermost layer of cells of the nucellus. The embryo-sac is itself divided by transverse septa into a row of three cells, the central and posterior of which must be regarded as antipodals, the anterior includes the large vegetative nucleus and the egg-apparatus. The two sterile synergidæ are prolonged at their apex into slender conical points which project into the endostome. At the time of impregnation, the embryo-sac completely fills up the integument, the two posterior cells occupying from two-thirds to three-fourths of its entire space.

Bidens leucantha and *Zinnia tenuiflora* present the same peculiarities as *Helianthus annuus* in almost every respect; and others of the Heliantheæ have the same structure in its general features. In *Tussilago Farfara* the base of the embryo-sac is occupied for about one-third of its length by a group of cells resulting from cell-division; while in other genera belonging to the Cichoriaceæ the group of antipodals has developed into a parenchymatous tissue. In the dandelion they are four or five in number, and form a single row in the narrowed conical posterior end of the embryo-sac. These characters are, therefore, of but little importance for purposes of classification.

The innermost layer of cells of the integument above described, or endoderm, is especially developed in many, though not in all, ovules with a single thick integument, in which the nucellar tissue disappears entirely before impregnation, as in the Compositæ, Valerianaceæ, Dipsaceæ, Campanulaceæ, Umbelliferæ, and Araliaceæ; less often in ovules with a double integument, as in *Linum*. Its cells are elongated in the radial direction, cubical, or even tabular. The layers of cells of the integument next to the endoderm often begin to be converted into mucilage even before impregnation.

Flowering of Amorphophallus.†—Dr. O. Beccari describes the flowering and formation of the fruit in *Amorphophallus Titanum*, the flower of which is probably the largest in existence. The production of the colour and odour of decomposing raw flesh, which attracts insects for the purpose of impregnation, is ascribed to a much greater plasticity of the protoplasm in past ages than it at present manifests; this being the basis on which natural selection and the struggle for existence worked.

* Bot. Ztg., xlvii. (1889) pp. 805–12, 821–6, 837–42 (1 pl.).

† Boll. R. Soc. Toscana Orticultura, 1889 (3 figs.). See Bot. Centralbl., xli. (1890) p. 60.

Scattering of the Pollen in Ricinus.*—Prof. F. Delpino describes the mechanism by means of which the anthers of *Ricinus communis*—a strictly anemophilous species—suddenly open to discharge their pollen, and which differs from the mechanism for a similar purpose in some Urticaceæ. It consists of four distinct movements, viz.:—(1) a movement of separation resulting from the opening of the valves; (2) a movement by which the lamina of the valve changes from concave to convex on its internal face; (3) a movement by which the lamina changes suddenly from convex to concave; (4) a movement by which the valves again approach one another.

(2) Nutrition and Growth (including Movements of Fluids).

Parasitism of the Mistletoe.†—Dr. C. v. Tubeuf points out the want of definiteness in the particulars of the composition of the ash of the mistletoe hitherto recorded. In order to learn the laws which govern the drawing of the nutriment of the parasite from the host, we want to know the age of the leaves, whether one or two years, on what part of the host it is parasitic, and to have a comparison of the ash of the host and of the parasite. The author records examples of the parasitism of the mistletoe on itself, on *Loranthus europæus,* and on different species of *Quercus.*

Effect of the "Ringing" of Stems.‡—Prof. R. Hartig points out that by the "ringing" of the bark of trees below the lowest leafy branch, growth and the deposition of food-material are limited to the portion of the trunk above the ring. If the tree is young this results in its early death; but if it has already attained a considerable age, it may survive the ringing for a long period. The explanation of this appears to be afforded by the fact that the ultimate ramifications of the roots of such trees effect a union of growth with those of other uninjured trees of the same kind growing in the immediate vicinity, and from these absorb the food-material which they require for the growth of their roots and the portion below the ring.

Influence of Light on the vital conditions of plants.§—From the results of a series of experiments made on partially or entirely darkened leaves, Herr J. Busch draws the conclusion that the decomposition of chlorophyll is not a primary consequence of darkness, but that chlorophyll may remain as such unchanged for any length of time in the plant, if the cell itself remain in a living state, and that the destruction of the chlorophyll in the dark is the result of the death of the cell.

Influence of Thinning on the diametric growth in Fir-forests.‖—M. E. Mer states that thinning favours the growth both in height and in diameter of the reserved trees. It is at the base of the trunk that the

* Malpighia, iii. (1889) pp. 337–8.

† SB. Bot. Verein München, Dec. 9, 1889. See Bot. Centralbl., xli. (1890) pp. 43, 78, 80, and 135. Cf. this Journal, 1888, p. 86.

‡ SB. Bot. Ver. München, Jan. 13, 1890. See Bot. Centralbl., xli. (1890) pp. 251 and 283.

§ Ber. Deutsch. Bot. Gesell., vii. (1889), Gen.-Versamml.-Heft, pp. 25–30.

‖ Bull. Soc. Bot. France, xxxvi. (1889) pp. 412–4. Cf. this Journal, 1889, p. 669.

increase in the width is most noticed, and the amount of the increase varies according to the distance of the trees which have been cut down from those reserved.

Conduction of Water.*—Herr F. Tschaplowitz describes a series of experiments which tend to the conclusion that air-pressure and capillarity play but a very subordinate part in the movement of water in plants, the really important factors being osmose and imbibition. The experiments were made chiefly on *Spiræa opulifolia*.

Causes of the Ascent of Sap.†—Dr. J. Boehm adduces additional arguments in favour of his view that the absorption of water through the roots and the ascent of sap are the result of capillarity, the retention of the water in the parenchyme of the leaf being caused by the pressure of air. The objection that Conifers do not contain true vessels he answers by the statement that they do possess what are at least physiologically equivalent to vessels.

Literature of Transpiration.‡—Dr. A. Burgerstein completes his *résumé* of the literature of transpiration by an abstract of all papers on the subject published from 1887 to 1889. The papers referred to are eight in number, and the whole subject (including "guttation" or the exudation of drops of fluid) is discussed under a number of different headings, reference being made to the conclusions arrived at by earlier observers.

(3) Irritability.

Nutation of Seedlings.§—Herr H. Molisch describes a new apparatus for demonstrating the hydrotropism of roots. It consists of a clay funnel with curved and perforated margin, filled with moist sawdust; the roots of seedlings planted in it pass through the orifices, and grow upwards on the moist wall of the erect funnel. This form of nutation has received at present much less attention than the curvature of aerial shoots.

Irritability of the Laticiferous tissue in Lactuca.‖—Prof. F. Delpino has observed in *Lactuca virosa* and some other species of the genus, a singular extreme irritability. If, in the warm weather, the epiderm which covers the bracts and involucre is touched with an excessively delicate substance, not sufficient to rupture the epiderm, a minute drop of latex is suddenly shot out from the laticiferous tissue. This serves to explain the extraordinary immunity of these species of *Lactuca* from the attacks of insects.

Galvanotropism.¶—From the results of a detailed series of experiments, Herr J. Brunchorst draws the conclusion that the curvature

* 'Beitr. z. Lehre v. d. Wasserbewegung in d. Pflanze,' 8vo, 8 pp. See Bot. Centralbl., xli. (1890) p. 149.

† Ber. Deutsch. Bot. Gesell., vii. (1889), Gen.-Versammł.-Heft, pp. 46–56 (2 figs.). Cf. this Journal, 1886, p. 824.

‡ Verhandl. K.K. Zool.-Bot. Gesell. Wien, xxxix. (1889) pp. 399–463. Cf. this Journal, 1888, p. 259.

§ 'Das Bewegungsvermögen d. Keimpflanze,' Wien, 1889, 8vo, 27 pp. and 7 figs. See Bot. Centralbl., xl. (1889) p. 214.

‖ Malpighia, iii. (1889) pp. 355–7.

¶ 'Notizen üb. d. Galvanotropismus,' Bergen, 1889, 8vo, 35 pp. See Bot. Centralbl., xli. (1890) p. 257. Cf. this Journal, 1886, p. 104.

towards the posterior pole, which is caused by a strong galvanic current, is the result of chemical processes which take place at that pole. Curvature towards the negative pole resembles heliotropic and geotropic curvatures in the fact that it takes place when the galvanic current acts only upon the apex of the root. This may or may not be a purely chemical irritation dependent on the formation of hydrogen peroxide.

(4) Chemical Changes (including Respiration and Fermentation).

Digestion of Albuminoids by the leaves of Pinguicula.*— From a series of observations on *Pinguicula vulgaris*, Herr N. Tischutkin has come to the conclusion that the digestive processes effected by the mucilaginous secretion from the glands on the leaves is not due to any fermentative substance contained in the fluid itself, but to the action of the bacteria which always accompany the putrefaction of the organic substance. The experiments were made both with dead flies and with small pieces of boiled white of egg.

Action of Carbonic Acid on the products of Fermentation.†— M. Luidet's memoir on the influence of carbonic acid on the fermentative process discusses the question whether alcohol exerts an inhibitive influence on the vegetation of yeast. We may take as an example of his meaning the question, when wort contains 13–15 per cent. of alcohol, does therefore fermentation cease? Against this the author asks whether the chief product of saccharine fermentation, carbonic acid, does not rather, after a certain point has been reached, exert a similar inhibitive influence on the yeast. He endeavours to answer the question in the following way:—In four equal sized flasks he fermented equal quantities of wort with like amounts of yeast, and so arranged it that the carbonic acid pressure should be different in each flask; the pressure of CO_2 in the first flask being equal to 0·2 cm. of mercury, in the second to 20 cm., in the third to 43 cm., and in the fourth to 60 cm. The result showed that the carbonic acid pressure had no influence on the course or products of fermentation. The determination of the alcohol formed and the quantity of the yeast gave in all cases such identical results that the author concludes that carbonic acid development had no inhibitive influence on the vital activity of yeast.

Ferment-action of Bacteria.‡—Drs. T. Lauder Brunton and A. Macfadyen have been making a series of experiments with Koch's comma-spirillum, Finkler's comma-spirillum, a putrefactive micrococcus, scurf bacillus, and a bacillus isolated from milk by Dr. Klein. They come to the conclusion that the bacteria which liquefy gelatin do so by means of a soluble enzyme. This enzyme can be isolated, and its peptonizing action demonstrated apart from the microbes which produce it. The most active enzyme is that formed in meat-broth, and its action is hindered by acidity and favoured by alkalinity. The bacteria which form a peptonizing enzyme on proteid soil can also

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 346–55.

† Bull. Soc. Chem. Paris, sér. iii. tom. ii. No. 4, Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii (1890) p. 62.

‡ Proc. Roy. Soc., xlvi. (1890) pp. 542–53.

produce a diastatic enzyme on carbohydrate soil. The latter is not so easily separated from the microbes which produce it; but when that has been accomplished, its action on starch can still be demonstrated. This diastatic enzyme has no effect on gelatin. The bacteria are capable of evincing an adaptiveness to the soil in which they grow. The microbes are capable of digesting other similar bodies such as dextrin and muscle, but were not found to have any influence on fat.

γ. General.

Phenomena of Etiolation.*—Dr. E. Godlewski points out that it is incorrect to speak of etiolated organs as sickly, at least in their early stages. The chief characters of etiolated parts of plants, viz. smallness of the leaves and lengthening of the internodes, the smaller degree of firmness, and the larger amount of water, and, in the case of Monocotyledons, the greater breadth and smaller length of the leaves, are all of advantage to the underground parts, in diminishing the consumption of food-material. It is only when the duration of these characters is unduly prolonged in the parts exposed to the air, that the plant becomes sickly and finally dies. By observations made on *Phaseolus multiflorus*, the author demonstrated that the average proportion of water is considerably greater in the etiolated portions beneath the surface of the soil than in the parts exposed to the air.

Influence of the Sea on the Structure of Leaves.†—M. P. Lesage finds, from differences in structure in leaves of individuals of the same species grown near to or remote from the sea, that the effects of the saline air and soil are to increase the thickness of the leaf, and especially the development of the palisade-parenchyme; to diminish the intercellular spaces; and to decrease the amount of chlorophyll in the cells.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Stem of Selaginellaceæ.‡—M. Vladescu describes the structure of the various tissues which compose the stem of Selaginellaceæ, especially those which proceed from the middle of one of the three cells which result from the third division of the original initial cell of the stem. From the further segmentation of the middle and internal of these segments proceeds a conducting tissue, consisting of the vascular tissue, the liber-tissue, and the conducting parenchyme; this last comprising the fascicular parenchyme (Strangparenchym), pericycle, endoderm, trabecular cortex, and internal cortex. The boundary, therefore, between the central cylinder and the cortex cannot, as Van Tieghem proposes, be placed between the pericycle and the endoderm; rather, all the tissues outside the liber must be referred, with Treub and Russow, to the cortex. All the tissues above described in the stem occur again in the root, and with a perfect continuity between the corresponding tissues in the two organs.

* Biol. Centralbl., ix. (1889) pp. 481–9, 617.
† Comptes Rendus, cix. (1889) pp. 204–6.
‡ Journ. de Bot. (Morot), iii. (1889) pp. 261–6.

Muscineæ.

Rhizome and Stem of Mosses.*—M. E. Bastit makes a comparison between the underground stem and the aerial leafy stem of mosses. The principal points noted are the following:—The underground stem has an epiderm provided with hairs, while the aerial stem is destitute of hairs. The underground stem has no hypoderm, while the aerial stem has one. The underground stem possesses three bundles and a very reduced cortex, with no pericyclic zone; the aerial stem possesses numerous foliar bundles, a very much developed cortex, and a pericyclic zone. Finally, in the underground stem the pith is much developed and of a uniform structure, while in the aerial stem the pith is reduced, and is separable into two regions, the one central and the other peripheral.

The following are the conclusions drawn by the author:—(1) That the stem of mosses is bounded by a true epiderm, characterized during the underground life by the production of absorbing hairs, and during the aerial life by the existence of a cuticle, and by intense cutinization of the walls. (2) The laminæ of the scales and of the leaves are of epidermal origin. (3) The venation of the scales and the leaves is of internal origin. (4) The hypodermal zone of the aerial stem corresponds to the three peripheral angles of the rhizome. (5) The pericyclic zone of the aerial stem corresponds to the three sectors situated at the periphery of the pith of the rhizome. (6) In passing from the underground to the aerial portion, the diameter of the central cells of the pith and the lignification of their walls increase, while the peripheral elements undergo inverse modifications.

Algæ.

Genera of Florideæ.†—Prof. F. Schmitz gives a synopsis of the genera of Florideæ hitherto described, which he classifies in four series, viz. Nemalioninæ, Gigartininæ, Rhodymeninæ, and Cryptoneminæ; and the following families:—In the first, Lemaneaceæ, Helminthocladiaceæ, Chætangiaceæ, and Gelidiaceæ; in the 2nd, Acrotylaceæ, Gigartinaceæ, and Rhodophyllidaceæ; in the 3rd, Sphærococcaceæ, Rhodymeniaceæ, Delesseriaceæ, Bonnemaisoniaceæ, Rhodomelaceæ, and Ceramiaceæ; in the 4th, Gloiosiphoniaceæ, Grateloupiaceæ, Dumontiaceæ, Nemastomaceæ, Rhizophyllidaceæ, Squamariaceæ, and Corallinaceæ. These are again in many cases divided into subfamilies, and the genera enumerated under each. Under each genus the name is also given of its typical species.

Wrangelia, Naccaria, and Atractophora.‡—Herr O. E. Zerlang has carefully investigated the structure of the thallus, the reproductive organs, and the mode of fertilization, in *Wrangelia penicillata*, *Naccaria Wigghii*, and *Atractophora hypnoides*, and finds sufficient distinctive characters to keep these three genera of Florideæ apart, although agreeing in their main features.

In all three genera the fertilized oosphere itself, with or without previous fusion with adjoining cells, developes into the gonimoblast

* Bull. Soc. Bot. France, xxxvi. (1889) pp. 295–303.
† Flora, xlvii. (1889) pp. 434–56 (1 pl.). ‡ T. c., pp. 372–407 (1 pl.).

(the term given by Schmitz to the entire fertile tissue of a single cystocarp which has resulted from the development of a single impregnated initial cell, whether this cell be an impregnated oosphere or an impregnated auxiliary cell). In all three this oosphere forms branched threads which expand within a definite section of the fertile shoot along the central axis, and then put out numerous short lateral axes, radiating on all sides and projecting outwards. In all of them the terminal cells of these lateral axes congregate into a more or less dense peripheral hymenium, permeated by numerous paraphyses, and develope successively into carpospores. The differences between the three genera lie in the structure of the thallus, and in the special form of the cystocarp. In particular the cystocarp of *Naccaria* is much more complicated in structure than that of *Atractophora.*

Algæ which perforate calcareous shells.*—MM. E. Bornet and C. Flahault give a monograph of the species of algæ known to inhabit the shells of molluscs and other calcareous substances in the sea, or less often in fresh water. The species described are:—*Gomontia polyrhiza*, *Siphonocladus voluticola*, *Zygomitus reticulatus* sp. n., *Ostreobium Queketii* n. sp., *Mastigocoleus testarum*, *Plectonema terebrans* sp. n., *Phormidium incrustatum*, *Hyella cæspitosa*, *Lithopythium gangliiforme* sp. n., and *Ostracoblabe implexa* sp. n. Of these the last two are probably Fungi; all the rest belong either to the Chlorosporeæ or the Phycochromaceæ. All the species present the same general mode of development. At first they expand horizontally in the epidermal layer of the shell, either in the form of an irregular network, or radiating from a central point. From this layer proceed branches which penetrate vertically into the test, and others which elongate parallel to the original ones, finally becoming so numerous that the calcareous substance entirely disappears, when they become exposed and produce abundantly their reproductive cells.

The preparations were in all cases made by first removing the calcareous substance by means of Pérényi's fluid—4 volumes of 10 per cent. nitric acid, 3 volumes of alcohol, and 3 volumes of 0·5 per cent. chromic acid.

Ecklonia.†—Dr. G. B. De Toni gives a monograph of this boreal and Australasian genus of Phæosporeæ, with a description of each of the six known species, and of its geographical distribution.

Spines of Xanthidium.‡—Herr F. Elfving finds that the spines of *Xanthidium aculeatum* originate as hollow protuberances, and cannot therefore be formed by apposition.

Apiocystis.§—Mr. S. Le M. Moore describes the life-history of *Apiocystis Brauniana*, found growing on *Cladophora* and *Mesocarpus*. In its earliest condition it consists of a colourless sac containing a single gonid, from the distal end of which proceed two cilia, which pierce the wall of the parent-cell and extend some distance into the surrounding water. This gonid divides by a number of successive bipartitions, the original

* Bull. Soc. Bot. France, xxxvi. (1889.) Actes du Congrès de Bot., pp. cxlvii.–clxxvi. (7 pls.).
† Notarisia, iv. (1889) pp. 782–90.
‡ Bot. Notiser, 1889, pp. 208–9.
§ Journ. Linn. Soc. (Bot.), xxv. (1890) pp. 362–80 (3 pls.).

mother-cell becoming a pyriform or spheroidal zoosporange, containing a large number of biciliated zoospores, arranged upon its wall, the very long cilia projecting through apertures in the cell-wall, and attached by a narrow stalk to some filamentous freshwater alga. The gonids ultimately escape either through the rupture of the cell-wall or its dissolution, and swim about by means of their cilia. *Apiocystis* occurs also in a cœnobial phase, the cœnobe, which frequently contains only two zoospores, becoming detached, and swimming about within the zoosporange. These cœnobes are motile by means of exserted cilia proceeding from the zoospores, similar to those of the fixed zoosporange. Three distinct resting-stages, a *Palmella*, a *Glœocystis*, and a *Botryococcus* phase, are also described.

When in the fixed state, the cilia of *Apiocystis* are perfectly motionless, and the author regards the genus as a degenerate type of Volvocineæ, which has exchanged its mode of life as a motile cœnobe moving about with great rapidity by its powerful cilia, for an attached existence in which the cilia have become atrophied. Its nearest allies will be *Pandorina* and Borzì's *Physocytium*.

Nematophyton.*—Prof. D. P. Penhallow describes five species of this genus of fossil algæ from the Devonian strata of Canada, some of which have been placed in the genera *Prototaxites*, *Nematophycus*, *Nematoxylon*, and *Celluloxylon*. He describes the genus as consisting of plants with arborescent form from a branching root-like base; the stem branching, often exceeding an inch in diameter, composed of unjointed interlacing structureless cells, which branch into an intercellular system of small and closely woven filaments.

Fungi.

Development of Ascomycetes.†—Herr H. Zukal describes a series of observations on a number of Ascomycetes, including several new species, viz. *Melanospora coprophila*, *M. fallax*, *Penicillium luteum*, and *Ryparobius pachyascus*. From the history of development in some of these species he establishes a close phylogenetic connection between certain species of *Ascobolus* and *Peziza*, and the Mucorini which are destitute of a columel. In another section of the Ascomycetes, including the Tuberaceæ, Dothideæ, and many Perisporeæ and Pyrenomycetes, the wall of the receptacle appears as a modified mycele or thallus, from which there may be developed either microconids (in the spermogones), megaconids (in the pycnids), or asci.

In the ascogenous hyphæ of the Sordarieæ, the author recognizes in the first instance a physiological apparatus, which serves chiefly for supplying the asci and ascospores with protoplasm and other nutrient materials. The organism hitherto described as autonomous under the name *Helicosporangium parasiticum* (Karst.), as a parasite upon *Melanospora leucotricha*, he has now determined to be a peculiar kind of sclerote belonging to the latter species, which he calls a *microsclerote*. It is, in fact, a receptacle modified by unfavourable vital conditions, and

* Trans. Roy. Soc. Canada, vii. (1889) pp. 19–30 (2 pls.). Cf. this Journal (1889) p. 560.

† SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 520–603 (4 pls.).

occurs also on other species of *Melanospora* and *Sporormia*. After a period of rest it developes into a perithece.

From the mode of development of the asci and fructification, Herr Zukal places *Penicillium* among the Gymnoasci. The mode of ejection of the ascospores in several species of *Ascobolus* and in *Ryparobius pachyascus* is described. In the last-named a hypha is differentiated at a very early period at the base of the primary weft of hyphæ, which is identical with the scolecite of *Ascobolus*. *Thelebolus* is probably an archaic form from which both *Ryparobius* and *Ascobolus* have been derived.

Finally Zukal supports de Bary's view of the sexual origin of the fructification in a large number of the Ascomycetes.

Lowly-organized Lichen.*—Herr H. Zukal finds on *Sphagnum* and other mosses a gelatinous mass consisting mainly of the alga *Palmella botryoides* var. *heterospora*, permeated by a very delicate mycele proceeding from the peritheces of a very thin-walled Sphæriacea. A branch of the mycele ramifies to each algal cell, and becomes closely applied to it, but without penetrating it. There appears to be a symbiotic relationship between the two, the growth of the algal cells being rather promoted than hindered, and Herr Zukal regards the organism as a lichen, to which he gives the name *Epiglœa bactrospora*.

Pyrenomycetes.†—Herr K. Starbäck describes three new species of Pyrenomycetes, and proposes that the family should be divided into two groups, viz. those in which the spores are ejaculated from the perithece, and those in which they escape by the conversion of the hymenium into mucilage. The latter is probably the more common mode, but has at present been determined in only a few Pyrenomycetes. He further points out that in *Chætomium* the hairiness of the perithece is of great advantage to the fungus by promoting the dissemination of the spores by insects. The entire perithece is attached so loosely to its substratum that when an insect comes into contact with it, the entire fungus becomes attached to its body.

Trichophila, a new genus of Sphæropsideæ.‡—Herr C. A. J. A. Oudemans describes this new genus belonging to the family Leptostromaceæ, of Sphæropsideæ, with the following diagnosis:—Stroma applanatum effusum piceum, intus p. m. distincte plurilocellatum, pallidius, basi propria destitutum. The only species, *T. Myrmecophagæ*, was found among the hairs of an ant-eater.

Bommerella.§—M. E. Marchal describes the cultivation of *Bommerella trigonospora*, characterized by its singular triangular ascospores, on rabbit's dung. It produces two kinds of spore, ascospores and conids, but the one may pass insensibly into the other. There is no production of any sexual organs whatever on the mycele; the peritheces are strictly apogamous. Light appears to exercise an injurious effect on the development of the peritheces, but to favour that of the conids.

* Versamml. K.K. Zool.-Bot. Gesell. Wien, xxxix. (1889), SB. p. 78.
† Naturv. Studentsällsk Upsala, Nov. 8, 1888. See Bot. Centralbl., xli. (1890) pp. 249 and 278.
‡ Hedwigia, xxviii. (1889) p. 361.
§ Bull. Soc. Roy. Bot. Belgique, xxviii. (1889) Pt. i., pp. 261–71 (1 pl.). Cf. this Journal, 1886, p. 293.

Oedocephalum and Rhopalomyces.*—M. A. de Wevre discusses the systematic position of these genera of fungi, which he places in the first of Costantin's four great groups of Mucedineæ, in which the spores are inserted on a special apparatus in the form of a rounded or spherical vesicle.

Fungus parasitic on Mushroom.†—Dr. O. Stapf describes the attacks of a parasitic fungus which are extremely destructive to mushroom-beds in Vienna. The diseased mushrooms are infested by a *Saccharomyces*, probably *S. glutinis*, but this is always preceded by the appearance of a mould, *Verticillium agaricinum*, covering the beds with a dense weft of delicate hyphæ, and producing abundance of conids. The *Verticillium* is undoubtedly the conidial form of an ascomycetous fungus belonging to the family Sphæriaceæ, and the genus *Hypomyces* or some other nearly allied to it; but the exact species the author was unable to determine, though it is probably *Mycogone Linkii.*

Slime-disease of Horse-chestnut.‡—Herr F. Ludwig finds on horse-chestnuts in the avenues in Thüringia a mucilaginous fungus-disease resembling that previously described in the case of apple-trees. It occurs also on oaks and birches, in the latter case in connection with *Polyporus betulinus.* The attacks of the parasite are accompanied by a fermentative process. When the mucilage is of a brown colour, *Torula monilioides* was found; in the black patches on the beech, an alga, *Scytonema Hoffmanni*, lives in symbiosis with the bacteria. A process of fermentation was also abundantly observed on the bark and exuded gum of cherry-trees, due to the action of *Coryneum Beyerinkii.*

Micro-organisms of Fermentation.§—A. Jörgensen's work on the microbes of industrial fermentation has recently reappeared in a second edition. The number of pages has been increased from 138 to 188, and the figures from 36 to 41. The book is divided into six chapters which deal with the methods of fermentation, microscopical preparation, pure cultivations, analysis of air and water, bacteria, moulds, alcoholic ferments, the progress made in the art of fermentation, and the improvements for which the trade is indebted to it.

New Puccinia.||—Herr F. Ludwig describes a new species of *Puccinia*, *P. Saccardoi*, belonging to the section *Pucciniopsis*, parasitic on the leaves of *Goodenia geniculata* in South Australia. Among the normal teleutospores occur others, unicellular or tricellular, sometimes of enormous size, and, occasionally, singular hornlike branched spores, resembling those of *Phragmidium obtusum.*

Autobasidiomycetes.¶—Following up his account of the first family, the Dacryomycetes, Herr O. Brefeld now proceeds to a description of the other families of this group of Fungi.

* CR. Soc. Roy. Bot. Belgique, 1889, pp. 128–33.

† Verhandl. K.K. Zool.-Bot. Gesell. Wien, xxxix. (1889) pp. 617–22.

‡ Deutsch. Bot. Monatensch., 1889, 2 pp. See Bot. Centralbl., xli. (1890) p. 299. Cf. this Journal, 1889, p. 795.

§ 'Die Micro-organismen der Gährungsindustrie,' 2nd edition, Berlin. See Annales de Micrographie, ii. (1890) pp. 252–3.

|| Hedwigia, xxviii. (1889) pp. 362–3.

¶ 'Unters. a. d. Gesammtgebiete d. Mykologie,' Heft 8, Leipzig, 1889, 307 pp. and 12 pls. See Bot. Centralbl., xli. (1890) pp. 51 and 87. Cf. this Journal, 1888, p. 778.

The second family or CLAVARIEÆ includes the genera *Typhula*, *Pterula*, *Clavaria*, *Pistillaria*, and *Sparassis*, and doubtfully *Microcera*.

The TOMENTELLEÆ are separated from the Thelephoreæ, and include those genera with no well-developed hymenium or receptacle, the basids springing directly from the mycele, viz.:—*Pachysterigma* g. n., *Hypochnus*, *Tomentella*, *Exobasidium*, and *Corticium*. *Pachysterigma* consists of four species of minute fungi,* composed of thick, loosely interwoven mycelial threads with but few clamp-connections on the septa. The basids spring directly from these filaments as lateral pear-shaped or spherical swellings, and produce from four to eight sterigmas. These latter swell into a globular form, and put out long protrusions, on which arise the large round or elongated spores; on germination these form secondary spores, but no other kind of fructification. *Exobasidium* differs from the other Tomentelleæ in its parasitic mode of life; *Corticium* includes the most highly developed forms of the order.

To the THELEPHOREÆ in the more limited sense of the term belong the genera *Stereum*, *Cyphella*, *Thelephora*, and *Craterellus*.

In the HYDNEÆ the hymenium is more fully developed than in the previous families, but not so much so as in the Agaricineæ and Polyporeæ; but many of the genera bear an external resemblance to genera in those families; thus *Odontia* and *Grandinia* to *Corticium*, *Phlebia* to *Merulius*, *Irpex* to *Dædalea* and *Lenzites*, the pileoid forms to corresponding genera of Polyporeæ. The genera are described in detail.

The numerous genera of AGARICINEÆ are then described, including the oidium-form in several genera, and the formation of chlamydospores in *Nyctalis*.

Among POLYPOREÆ, in addition to *Porothelium*, *Solenia* (intermediate between Polyporeæ and Thelephoreæ), *Merulius*, *Favolus*, *Dædalea*, *Hexagona*, *Trametes*, *Polyporus*, *Fistulina*, and *Boletus*, two new genera are described, viz. *Oligosporus* and *Heterobasidion*, both separated from *Polyporus*. Besides basids, there occur also in the family oidia, chlamydospores, and conids. *Oligosporus* embraces those species hitherto included under *Polyporus* in which the formation of hymenium with basidiospores is almost entirely suppressed, the ordinary mode of propagation being by abundant chlamydospores; it includes three species. *Heterobasidion* is founded on *Polyporus annosus* Fr. (*Trametes radiciperda* Hart.).

The Autobasidiomycetes are distinguished from the Protobasidiomycetes by their unseptated basids; the latter include the angiocarpous Pilacreæ, the gymnocarpous Auricularieæ, and the Tremellineæ; the former the Dacryomycetes, Tomentelleæ, Thelephoreæ, Gasteromycetes, and Hymenomycetes. In the Protobasidiomycetes, conids are almost the only form of secondary reproductive bodies; among the Autobasidiomycetes, we find frequent formation of chlamydospores, of which oidia are the simplest form. The Thelephoreæ and Tomentelleæ, being entirely gymnocarpous, are the simplest orders of the family. The conids are an independent form of fructification, and do not vary in character throughout the Basidiomycetes. Basids are formed by progressive development from the conidiophores, and show considerable diversity in

the different groups:—In *Pilacre* and the Auricularieæ they are elongated and filiform, septated horizontally, and with lateral spores; in the Tremellineæ septated transversely; in the Autobasidiomycetes they are not septated. The relationship of the various groups to one another, as shown by the structure of the basids, is closely worked out. The chlamydospores which, in their simplest form, are simply short fragments of hyphæ, attain a great variety of development in the Uredineæ and Ustilagineæ,* where the true reproductive organs are so greatly suppressed that the fungi become conspicuous only through the germination of the chlamydospores. The unseptated sporophores of *Entyloma* and *Tilletia* with apical spores closely resemble perfect basids, and the Ustilagineæ are therefore nearly related to the Basidiomycetes. In the Uredineæ, besides three different kinds of chlamydospores, there are also spermogones with "spermatia" and promyceles with sterigmas, or two different forms of conids. The Uredineæ are, therefore, a family of Protobasidiomycetes with gymnocarpous rudiments of basids. The relationship is further traced between these families of Fungi and the Oomycetes, Zygomycetes, and Ascomycetes.

Schröter's Cryptogamic Flora of Silesia.†—The first half of the third volume of this important work contains all the orders of Fungi except the Ascomycetes and the Imperfectæ. The author separates the Chytridiaceæ and the Zygomycetes from the Oomycetes, erecting them into an independent and a parallel series; the Zygomycetes being either derived from the Protococcaceæ through the Chytridiaceæ, or the latter from the Zygomycetes by retrogression. In the Uredineæ he regards the teleutospore-layer rather than the æcidia as the analogue of the ascocarp of the Ascomycetes. The Basidiomycetes with transversely septated basids are separated as a special group under the name Auricularieæ; the Basidiomycetes themselves are divided into Tremellineæ, Dacryomycetes, and Eubasidiomycetes, the latter including the Hymenomycetes, Gasteromycetes, and Phalloideæ. *Protomyces* and the Ustilagineæ occupy a place intermediate between the Oomycetes and the Uredineæ.

Mycetozoa.

Classification of Myxomycetes.‡—Herr J. Schröter divides the Myxomycetes into the three following groups:—

A. Ripe fructification consisting of a mass of free spores.
  a. Saprophytes; the amœboid bodies unite into compound plasmodes without completely coalescing, ACRASIEÆ.
  b. Parasites in the interior of living cells, forming, as far as is known, true plasmodes, PHYTOMYXINEÆ.

B. Spores formed in the interior of sporanges or on the outside of disc-shaped or columnar fructifications; true plasmodes, MYXOGASTRES.

* Cf. this Journal, 1889, p. 787.

† Dritter Band, 1te Hälfte, Breslau, 1889, 8vo, 814 pp. See Bot. Ztg., xlviii. (1890) p. 76.

‡ Engler u. Prantl's Natürl. Pflanzenfam., 36 Lief., von J. Schröter, Leipzig, 1889. See Hedwigia, xxviii. (1889) p. 375.

The Acrasieæ comprise the genera *Copromyxa*, *Guttulina*, *Dictyostelium*, *Acrasis*, and *Polysphondylium;* the Phytomyxineæ, *Plasmodiophora*, *Phytomyxa*, *Tetramyxa*, and *Sorosphæra*. The numerous genera of Myxogastres or true Myxomycetes are divided into 11 families.

Pseudospora.*—Prof. C. Gobi describes the structure and development of this parasite on living *Vaucheriæ*. The motile naked masses of protoplasm develope a single cilium at the posterior end, and must then be regarded as zoogonids, and their mother-cells as zoocarps or zoosporanges. The zoogonids consume the protoplasm and the chlorophyll of the host; when mature, they multiply by repeated bipartition. Finally they become encysted into zoocarps, which may either reproduce zoogonids directly, or plasmamœbæ in the first place, of the form which the author calls actinophryds, globes with radially arranged pseudopods; these are reproduced in several ways. Both the zoogonids and the actinophryds can pierce the wall of the *Vaucheria*-sac, and, after they have moved about it for a time, transfer themselves to another one. The author traces a resemblance between the development of *Pseudospora* and that of *Plasmodium Malariæ*.

Protophyta.

a. Schizophyceæ.

Auxospores of Chætoceros.†—Herr F. Schütt describes the mode of formation of the auxospores in this marine genus of diatoms. In a cell in the chain which has attained its maximum length, the valve is perforated at a spot on its girdle-band, and the protoplasm protrudes as a small vesicle, and becomes invested by a fine shell, the entire protoplasm of the mother-cell finally passing into it. The nearly globular auxospore attains double or three times the diameter of the mother-cell, and then somewhat increases in length in the diameter at right angles to the axis of the mother-cell. The protoplasm then contracts, and becomes invested in a new siliceous coat, which gradually assumes the form characteristic of the genus, while the horns are at the same time gradually formed out of the surface of the valve, and break through the siliceous coat; the new cell, which is placed at right angles to the original chain, and is much larger than its component cells, now divides transversely.

Fossil Diatoms of Gianicolo.‡—Dr. M. Lanzi describes the diatomiferous deposit found near the summit of Monte Gianicolo, within the Roman basin, with a list of the species.

Cells of the Cyanophyceæ.§—Herr E. Zacharias has carefully examined the structure of the cell in the following genera of Cyanophyceæ, viz.:—*Oscillaria*, *Nostoc*, *Cylindrospermum*, *Tolypothrix*, and *Scytonema*. He finds in all cases, in the living cell, a central colourless portion, surrounded by a peripheral layer of protoplasm, in which alone the

* Ber. Gesell. öff. Gesundheitspflege, Petersburg, 1887 (Russian). See Bot. Centralbl., xxxix. (1889) p. 346.
† Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 361–3 (1 pl.).
‡ Atti Accad. Pontif. Nuov. Lincei, xlii. (1889) 9 pp.
§ Ber. Deutsch. Bot. Gesell., vii. (1889) Gen.-Versamml.-Heft, pp. 31–4, and Bot. Ztg., xlviii. (1890) pp. 1–10, 17–26, 33–43, 49–60, 65–70 (1 pl.).

pigment or cyanophycin resides, and which alone contains granular inclosures of various sizes. No vacuoles could be detected. The peripheral coloured protoplasm consists mainly of plastin; the inclosed granules are colourless and unstratified, and are insoluble in alcohol or ether, and do not give the ordinary albumen reactions. In the central portion are often found one or two bodies agreeing in their appearance and their chemical reactions with nucleoles. The mode of cell-division appears uniform in the genera named. The new division-wall makes its first appearance on the wall of the mother-cell as a circular ridge, which then gradually projects into the cell, and finally divides it completely in two. This is accompanied by a constriction of the central portion of the cell. This central portion cannot, however, in the opinion of the author, be correctly described as a nucleus, since it differs materially in its properties from ordinary cell-nuclei, although it presents the microchemical reactions of nuclein.

β. Schizomycetes.

New Type of Endosporous Bacteria.*—Prof. L. Klein describes a previously unobserved mode of endosporous formation of spores in a number of bacteria found in marshes, chiefly inhabiting partially decayed algæ, generally *Volvox* and *Hydrodictyon.* The spore is either terminal or median, the first indication of its formation being a swelling of the rod, and the protoplasm of this swelling, which always remains in communication with that of the rest of the rod, assumes a light green tint. The entire contents of the swollen part then contracts, separates itself from the cell-wall, increases in refrangibility, and gradually assumes the form of an endospore, which retains permanently its strong refrangibility and its blue-green tint. This peculiarity was observed in five species, all of them new, to which Dr. Klein gives the names *Bacillus de Baryanus*, *B. Solmsii*, *B. Peroniella*, *B. macrosporus*, and *B. limosus.* In all, except *B. Peroniella* and *limosus*, the ripe spore is somewhat bean-shaped; when the spores are terminal the end where they are placed is usually somewhat swollen; when motility was observed the sporiferous end was generally anterior.

The author traces a homology between the mode of formation of these spores and that of the cysts of the Flagellatæ; and suggests that the Schizomycetes consist of two groups not very closely related to one another phylogenetically, one forming endospores and nearer to the Flagellatæ, while the other may be regarded as Cyanophyceæ which have become saprophytic in their mode of life and colourless.

Symbiotic Organism of the Tubercles of Leguminosæ.†—Herr B. Frank points out that the symbiosis in the tubercles of Leguminosæ is of an entirely different character from that which occurs in the roots of any other plants, except the alder and *Elæagnus.* The infection always takes place from the soil, but in two different ways, either by means of hyphæ or without them; the latter is always the case in *Lupinus* and *Phaseolus.* The infecting hyphæ and the hypha-like bodies in the meristem of the host which are derived from them, do not differ

* Ber. Deutsch. Bot. Gesell., vii. (1889) Gen.-Versamml.-Heft, pp. 57–72 (1 pl.).
† T. c., pp. 332–46. Cf. this Journal, *ante*, p. 59.

essentially from the rest of the protoplasmic contents of the infected meristem-cells. The hyphæ have no true cell-wall; and the substance of which they and the rest of the contents of the meristem-cells is composed may conveniently be termed *mycoplasm.* The author suggests that the so-called hyphæ are in reality a formation from the protoplasm of the host designed for the reception of the symbiotic micrococcus or bacterium swarm-cells. For the infecting microbe he proposes the name *Rhizobium Leguminosarum*, and considers it rather a Schizomycete than a Myxomycete, though possibly allied to *Plasmodiophora Brassicæ.* The so-called "bacteroids" are not fungi, but formations from the protoplasm of the host in which the micrococcus of the microbe is contained. In *Phaseolus vulgaris* we have the simplest relation between the two symbionts; the microbe is a parasite performing no service to the host. In the lupin and pea the same is the case when the soil is rich in humus; but when the supply of humus is deficient the microbe-symbiont is of the greatest service to the host in promoting the various vital processes of assimilation, formation of chlorophyll, &c.

Morphological Constancy of Micrococci.*—Dr. G. Mirto concludes from his experiments made with various micro-organisms that there exists a large class of micro-organisms in the coccus form which preserve their morphological characters unchanged, however the external conditions of their existence may be varied; such micro-organisms never give rise to the formation of spores.

The micro-organisms made use of by the author in his investigation were *Micrococcus cinnabareus*, *M. roseus*, *M. cereus albus*, *M. radiatus*, *M. flavus liquefaciens*, *M. ureæ liquefaciens*, and an unclassified micrococcus. The media employed were gelatin, agar, potato, broth, and solid flesh. On these media, with the above-named microbes, the author made frequent observations, in all of which the morphological constancy of the organisms was maintained; the cocci always producing cocci at all periods of their growth and in the different cultivation media. Spore-formation was never observed.

Decomposition of Albumen by Anaerobic Schizomycetes.†—In his experiment M. von Nencki used *Bacillus liquefaciens magnus*, *B. spinosus*, and *Bacillus* of symptomatic anthrax. Flasks holding 4–10 litres were filled with sterilized serum albumen, and the air in the flasks replaced with CO_2, H, or N. In a few days fermentation began, with the development of gas. The decomposition-products of the three bacilli were the same. Among these the author found fatty acids, aromatic acids, and a new product of albumen decomposition, skatol acetic acid. This, with nitrite of potash and acetic acid, forms a yellow crystalline nitrous compound.

Bacteria found in Influenza‡—Secretions from the respiratory passages and juices from various organs from cases of influenza were used by Dr. V. Babès as intravenous and subcutaneous injections in guinea-pigs and rabbits. The animals were also infected by rubbing

* Bollettino Soc. Ital. Microscopisti, i. (1889) pp. 6–25.

† SB. K. Akad. Wiss. Wien, May 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 129–30.

‡ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 233–41.

their nasal mucosa with the tainted discharge. Many of the animals succumbed to the poison, but on the other hand, many survived, an inflammatory swelling only being developed at the place of inoculation. From the organs of the animals which died cultivations were made on agar, gelatin, and potato, and several forms of bacteria developed. Among these were *Staphylococcus pyogenes aureus* and *albus*, and also a *Staphylococcus* from 0·8–1 μ broad, which did not liquefy gelatin, and was not pathogenic. Of the bacilli, two forms distinguished as B i. and B ii. are specially noted. The colonies of bacillus i. are distinguished by being perfectly transparent and colourless. The individual elements, which are extremely small, from 0·2–0·4 μ thick, form small chains or threads. They are only faintly stained by anilin pigments, and not at all by Gram's method. They are quite motionless. Bacterium ii. was found to stain well. The primitive elements, usually in pairs, are about 0·5 μ broad, with pointed ends. Transverse striations could be detected. These bacilli did not grow on gelatin, but throve on potato. They were found to be pathogenic to mice and guinea-pigs, their chief effect being exerted in the lungs.

Besides the foregoing colonies of oval bacteria, slender bacilli and thick bacilli were also observed.

These observations were made from cases occurring during the height of the epidemic, and another set is given from cases of pneumonia, which started as influenza. Among the micro-organisms isolated from the latter cases were *Streptococcus pyogenes*, a lancet-shaped diplo-bacterium, and a bacterium the colonies of which formed mucous-looking masses below agar layers or upon gelatin. They were pathogenic to mice and rabbits.

Dr. Bouchard,* after narrating instances of the contagiousness of influenza, proceeds to say that he found three pathogenic microbes of influenza, "two of which are too many if we go for a specific virus of influenza." All these three microbes are the constant companions of the various cavities of the human body. Hence, in order to have any causal relation to influenza, they must have exceeded the ordinary conditions of their existence. The author's view that *Streptococcus pyogenes aureus* is the only microbe capable of producing pneumonia wants further corroboration. This microbe was isolated from the vesicles of *Herpes labialis*, and was found also in the pneumonias complicating influenza. *Streptococcus Pneumoniæ* was found by the author in the bronchial secretion, but not in the blood. This microbe is conconsidered by the author to be identical with the Streptococcus of erysipelas, of suppuration, and of puerperal fever.

Dr. T. M. Prudden † has examined seven cases of unmistakeable influenza. Cultivations were made on agar and agar-glycerin plates at the temperature of the body. The pathogenic forms discovered were *Staphylococcus pyogenes aureus*, *Streptococcus pyogenes*, and *Diplococcus pneumoniæ*. The author concludes that bacteriology has "brought to light no living germ which there is reason to believe has anything to do with causing the disease." When compared with Ribbert's investigation

* La Semaine Méd., 1890, No. 5. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 375–6.

† Medical Record, Feb. 15, 1890.

of a quite similar set of cases, i. e. influenza with and without pneumonia, it is found that the author discovers *Diplococcus pneumoniæ* in tolerable frequency, while Ribbert does not mention this microbe at all.

Dr. Ribbert * examined seven cases dead of influenza for bacteria. Cultivations were made from lungs, trachea, spleen, and kidney, on agar. Having found in five cases *Streptococcus pyogenes* vel *erysipelatis*, the author asks if this microbe can be the excitant of influenza. If this be the case it is obvious that this Streptococcus must have acquired, temporarily at least, pathogenic properties, differing a good deal from those usually attributed to it, but it may be acknowledged that, when once the disease has been set up, this micro-organism plays at least an important though secondary part.

Chicken-Cholera Microbes.†—Dr. O. Katz, who was entrusted with the investigation of the fowl-cholera question in Australia, finds that when material of undoubted virulence (blood pure cultivations) is subcutaneously injected, rabbits invariably succumb, and usually in a short time, some dying in 7–8 hours. When fed with food contaminated with these bacteria, the rabbits were nearly always found to die, the average duration of the disease being 18–25 hours.

The liquid medium used by the author for cultivation of the microbes was rabbit flesh infusion or broth. This was made by mixing finely chopped up rabbit flesh with twice its weight of distilled water, and allowing the mixture to stand for 24 hours in a cool place, stirring from time to time, filtering and pressing through cheese-cloth, steaming, filtering again, neutralizing with 20 per cent. aqueous solution of anhydrous carbonate of soda, steaming and filtering again, and ultimately filling into different sized cotton-wool-plugged sterilized test-tubes, which with their contents were thereupon discontinuously sterilized. Other cultivations were made with the foregoing fluid to which 1 per cent. peptone and 0·5 per cent. NaCl were added. Of the solid media the most used was a 6 per cent. rabbit broth peptone gelatin.

The author's experiments on the "immunization" conferred by sterilized broth cultivations against a subsequent infection by active cultures lead him to admit the great possibility of the protective power of this "vaccination"; but his experiments are too few for a certain conclusion.

With regard to the question, Is chicken cholera a contagious disease among rabbits? the author's experiments were considerably in favour of a positive answer; although, from the conditions under which the animals were placed, these experiments were marred in consequence of the great mortality due to causes other than chicken-cholera.

The question whether the virus of chicken-cholera is affected by its transmission through rabbits in successive generations, is answered in the negative. For this purpose twenty generations were used, and on summing up the results the author found that there was neither an increase nor a decrease in the virulence.

Further experiments were made to ascertain how far certain indi-

* Deutsche Med. Wochenschrift, 1890, No. 4. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 273–5.

† Proc. Soc. Linn. N.S.W., iv. (1889) pp. 513–97.

genous and other birds were affected by the chicken-cholera microbe. The results appear to have been doubtful.

Pathogenic Micro-organisms of the Mouth.*—Dr. R. Kreibohm's investigation of the micro-organisms found in the mouth extended to *Leptothrix buccalis* and some pathogenic bacteria. From microscopical examination, and from cultivation, the author came to the conclusion that Leptothrix merely represents a peculiar phase of growth of different Schizomycetes. Four forms were observed to develope Leptothrix, two of which were bacilli, and two short bacteria.

Of the pathogenic microbes, the author was able to demonstrate four different species, of which three were not cultivable on the usual nutritive media. All four kinds were fatal to animals, producing a septicæmia, and they were afterwards found in the blood in large quantities.

Positive results were obtained only from the tongue-fur of sick persons, and best from those in condition of high fever. To only one of these micro-organisms is a name given, *Bacillus sputigenus crassus*, a short fat bacillus found in the sputum and tongue-fur of chronic bronchitis. These grew well on potato, agar and gelatin, and were easily stained by the customary methods. They were found to be very fatal to animals, producing gastroenteritis, pulmonary hæmorrhage, and death in a few hours. Sterilized cultures had the same effect.

Passage of Pathogenic Micro-organisms from Mother to Fœtus.†—Dr. M. Simon has endeavoured to solve the problem of the passage of pathogenic microbes from mother to fœtus by the microscopical observation of anthrax in rabbits. Cultivation experiments for determining the presence of the anthrax bacilli in the fœtus were not made.

According to the author, the placenta does not form a physiological filter for anthrax bacilli, which were found not only on the surface of the fœtus, but as deep down as the peritoneum.

Coarse pathological changes such as hæmorrhages were not observed in the placenta. Bacilli were detected in the fœtal placenta, in the amniotic fluid, and in the fœtus, but they were found to vary in quantity and in situation with the length of the disease.

Bacteria of the Normal Respiratory Tract.‡—Dr. L. von Besser has examined the secretion from the nasal cavities in 57 men of 20 to 60 years of age: 28 of these were convalescents, the rest being healthy individuals employed in the laboratory. The experiments were microscopical, cultural, and vaccinal. Of pathogenic microbes, *Diplococcus pneumoniæ*, *Staphylococcus pyogenes aureus*, *Streptococcus pyogenes*, and *Bacillus pneumoniæ* were discovered, and less frequently in the invalids than in the healthy persons. Of non-pathogenic bacteria, the author found *M. liquefaciens albus*, *M. albus*, *M. cumulatus tenuis*, *M. flavus liquefaciens*, and several others. The laryngeal and bronchial secretions were also made the subject of examination, and with analogous results.

* Inaugural-Dissertation Göttingen, 1889. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 312–3.

† Zeitschr. f. Gebürtshülfe u. Gynækologie, xvii. (1889) pt. 1. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 219.

‡ Beitr. z. Pathol. Anat. u. z. Allgem. Pathol., vi., No. 4. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 151–2.

Behaviour of the Virus of Cholera, Enteric Fever, and of Tuberculosis in Milk, Butter, Whey, and Cheese.*—Milk having been shown to be a vehicle for the transmission of certain diseases, e. g. scarlet fever, enteric fever, cholera and tuberculosis, Dr. L. Heim made experiments to ascertain the duration of viability of certain disease germs when cultivated in milk or the food-stuffs prepared from it, butter, whey and cheese. The author's results show that the germs were still capable of development in

	Cholera.	Enteric Fever.	Tuberculosis.
Milk after	6	35	10 days.
Butter ,,	32	21	30 ,,
Curds ,,	0	1	2 ,,
Whey ,,	2	1	14 ,,
Cheese ,,	1	3	14 ,,

Behaviour of Pathogenic Micro-organisms in Sea Water.†—Prof. de Giaxa, in examining the action of sea water on pathogenic micro-organisms, used the bacteria of cholera, anthrax or typhoid, and the *Staphylococcus pyogenes aureus*, while the sea water was obtained from different localities. In the result it was found that there was little difference between sea water and fresh water towards pathogenic microbes; for in the latter, when it has been sterilized, pathogenic microbes may live for a long time; but, when not sterilized, the competition between the common bacteria and the pathogenic microbes causes the latter to disappear with greater or less rapidity; the practical result of the author's experiments is that pathogenic microbes can resist the competition of the common bacteria for a certain time, and hence, if the conditions be favourable, they may become the source of direct or indirect infection.

Baumgarten's Annual Report on Pathogenic Micro-organisms.‡—The first half of this report for 1888 has just appeared. It notices, often at length, 514 monographs or books. This half is devoted to:—(1) Works on Microbiology, (2) Pathogenic Micrococci, (3) Bacilli.

Arloing.—**Immunité naturelle.** (Natural immunity.) (Soc. des Sciences Méd. de Lyon.) *Lyon Méd.*, 1889, No. 51, p. 605.

Braem, G.—**Untersuchungen über die Degenerations-Erscheinungen pathogener Bakterien im destillirten Wasser.** (Researches on the degeneration of pathogenic bacteria in distilled water.) Königsberg, 1889, 62 pp.

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* Arbeiten aus d. Kaiserl. Gesundheitsamte, 1889. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 152–5.

† Zeitschr. f. Hygiene, vi. p. 162. Cf. Annales de Micrographie, ii. (1889) pp. 86–9.

‡ See Annales de Micrographie, ii. (1890) pp. 253–4.

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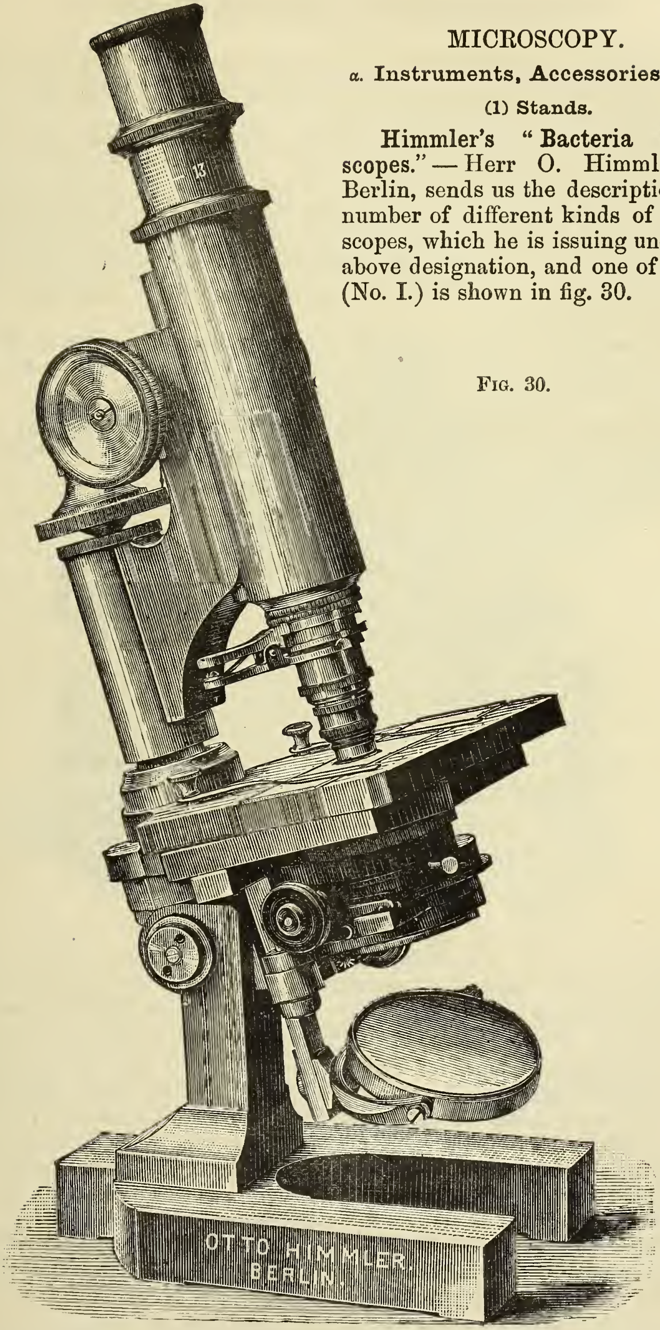
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Himmler's "Bacteria Microscopes." — Herr O. Himmler, of Berlin, sends us the description of a number of different kinds of Microscopes, which he is issuing under the above designation, and one of which (No. I.) is shown in fig. 30.

FIG. 30.



* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

Generally, the instrument, as will be seen, is on the Hartnack model, but with an Abbe condenser. The condenser is on an arm with rack and pinion, so that it can be instantaneously moved in and out of the axis, by racking it down and turning it to the left. The maker claims that "this is a great advantage as against the instruments of other makers which have not such a contrivance." The claim as made is too wide, as we have seen German instruments which have had a similar arrangement in principle, though it might be more generally applied, as it is often very inconvenient to be obliged to alter the position of the Microscope, and slide out the illuminating apparatus when it is desired to work without the condenser.

For rapidly changing objectives, the instrument, as shown in fig. 30, is supplied with a Fuess clamp, the objective being released by pressing the end of the "tongs" together against the spring.

Blackhall's Simple Microscope with Multiple Illuminator. — In this little instrument (figs. 31 and 32) sent us by Mr. W. Blackhall, an

FIG. 31.

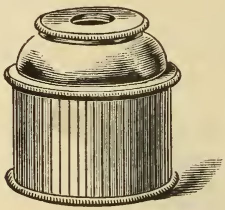
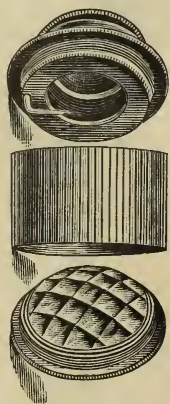


FIG. 32.



ingenious device has been made use of for illuminating the object, which is fixed on a pin in front of the simple lens. The bottom of the tube, in place of being closed by a convex lens, has a "multiplying glass," as shown in fig. 32, by the facets of which the light is thrown on the object.

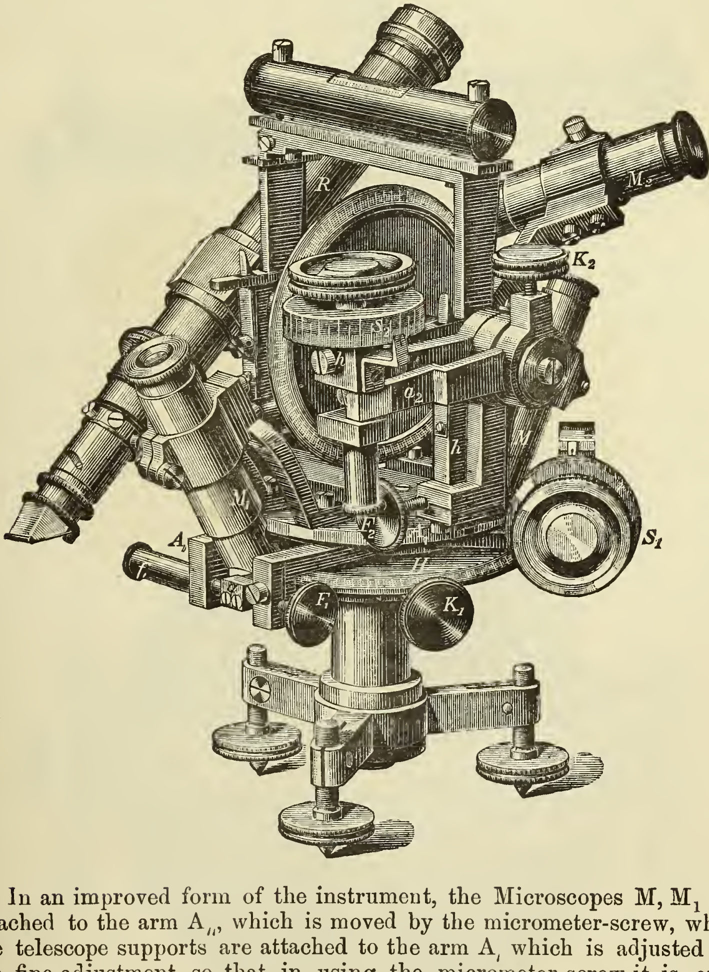
Heyde's Microscopes for Theodolites.*—Herr G. Heyde has designed an instrument intended to unite the advantages of the screw Microscope with the convenience of the small Hensoldt scale Microscope. It has not generally been found possible to apply the screw Microscope to small theodolites, on account of the inconvenience for transport, &c., and yet their accurately divided scales deserve a better method of reading than either the Vernier or Hensoldt Microscope.

In the new theodolite M, M_1 (fig. 33) are Microscopes with parallel wires for reading the horizontal scale H; they are attached to the arm $A_{,}$, which carries the supports of the telescope-axis. Below $A_{,}$ is a second

* Zeitschr. f. Instrumentenk., viii. (1888) pp. 171–6 (3 figs.).

arm $A_{,,}$, provided with two fine-adjustments; one at F_1 with a spring f_1 and clamping-screw K_1 serves for the azimuthal adjustment of the telescope R_1; the other S_1 serves to turn $A_,$ with respect to $A_{,,}$, and plays the part of the micrometer-screw in the screw Microscope. The Microscope M_2, which is used for reading the vertical scale, is connected in the same way with a micrometer screw S_2, which, after the telescope is adjusted to the right elevation, serves to measure the interval between the cross-wire and the image of the nearest division.

Fig. 33.



In an improved form of the instrument, the Microscopes M, M_1 are attached to the arm $A_{,,}$, which is moved by the micrometer-screw, while the telescope supports are attached to the arm $A_,$ which is adjusted by the fine-adjustment, so that in using the micrometer-screw it is only necessary to turn the Microscope-carrier through the small angle to be measured, while the telescope remains unmoved. The construction is

Fig. 34.

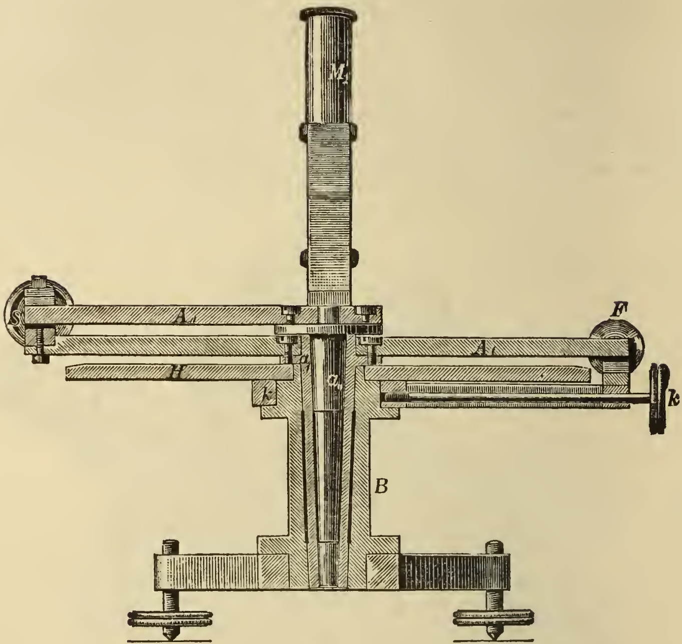
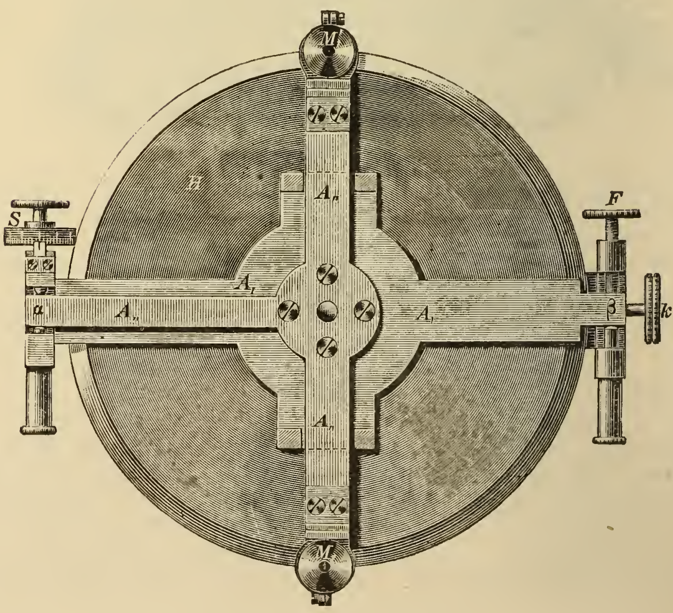


Fig. 35.



shown in figs. 34 and 35. B is the supporting column, and $A_{,}$ the principal axis, which contains a second axis $A_{,,}$ carrying the second arm $A_{,,,}$ to which the two Microscopes M_1 and M_1^1 are screwed. The principal arm $A_{,}$, connected with the axis a and carrying the telescope, has two prolongations, α and β, which extend beyond the divided circle. β is connected with the fine-adjustment screw F on the clamp k; and α carries the micrometer screw S. S serves to turn the Microscope arm $A_{,,}$ alone; while F moves the principal arm with the upper part of the instrument, and at the same time the Microscope arm. A second arm is not necessary on the vertical circle, where it is replaced by the telescope carrier. The circles being divided into one-third of a degree, a complete turn of the drum is made to correspond to 20 minutes, and it is divided into 200 parts, so as to read to tenths of a minute.

(2) Eye-pieces and Objectives.

Binocular Eye-pieces.—The late Mr. R. B. Tolles's binocular eye-piece has not yet been described in this country, and as inquiries are constantly made on the subject, the following description is reproduced with slight modifications from his original paper.*

" To apply the binocular principle to the eye-piece of a Microscope or telescope, it is only necessary to make use of the erecting form of eye-piece, and to place the dividing prism at the point where the pencils composing the whole bundle of rays proceeding from the object cross the eye-piece, which is the point where, in any erecting eye-piece, the diaphragm proper is correctly placed.

If the theory of the erecting eye-piece of common form were generally understood, no demonstration that binocularity can be given to such an eye-piece would be necessary. Suffice it to say that, since any one pencil of light proceeding from any point of the object through the *whole area* of the object-glass *does* at this point equally fill the whole area of the diaphragm (that being of proper aperture) substantially in the same manner, therefore the division for binocular vision, if made here by the appropriate prism, must be a very nearly equal division of every particular pencil, and give a similar and satisfactory image of the entire field in each eye-tube. This is a sufficient expression of the whole theory of the binocular eye-piece.

It is, however, important in order to avoid pseudoscopic effects, to adopt the proper form of dividing prism; and this form is precisely that best suited to that kind of binocular Microscope in which the dividing prism is placed immediately above the objective. The natural presumption has been—contrary to this—that prisms of rectangular form would give the proper effects in the eye-piece, because of the pseudoscopic effects produced by their use in the Microscope of binocular body. But this is an error, inasmuch as the pencils proceeding to form the second image in the erecting eye-piece reach the small dividing prism under conditions suitable for correct vision of the object *were the eye placed there*, and, accordingly, the same false appearances obtain with the eye-piece of rectangular prisms, *having oculars above*, as if such division were made immediately above the objective; the effect being,

* Silliman's American Journal of Science, xxxix. (1865) pp. 212–5 (1 fig.).

that the order in which the rays proceeding from the sides of the object or image viewed reach the eyes, as to right and left, is reversed from that which exists in natural vision; the left eye receiving a preponderating portion from the right side, and the right from the left side of the object.

It is to be noted, however, that the eye-piece with rectangular prisms, arranged after the first method of Prof. Riddell, does not uniformly produce conversion of relief, or that inversion of perspective which obtained in that first experimental arrangement for a binocular Microscope. Such a *binocular eye-piece* used in the Microscope upon transparent objects only occasionally gives the view in depth thus inverted. With low powers, and considerable thickness of the transparent object, the view is usually pseudoscopic. With medium and high powers, it is otherwise; and the effect is much controlled in this respect by the direction of the light upon the object.

When the binocular eye-piece with rectangular prisms is used in the telescope to view a landscape, the perspective is not *throughout* inverted, but portions of the field appear interposed between the eye and nearer objects in a singular and somewhat startling manner.

By arranging the compound rectangular prism so that the optical pencil is divided in the *plane of vision*, instead of vertically, the pseudoscopic effect is almost entirely obviated.

In constructing the binocular eye-piece, the prisms and arrangement of Nachet have been found to answer every condition and requisite of binocular vision. The dividing prism being placed, as before stated, at the point of crossing of the pencils in the erecting eye-piece, each pencil of light will enter the small dividing prism and impinge upon its reflecting surfaces in a manner similar to that illustrated in the Nachet binocular Microscope. The binocular eye-piece has greatly the advantage over the other arrangement. For when the prisms are placed *in the binocular body immediately above the objective*, their position, in order to secure a *proper division* of each transmitted pencil, should change with every change of objective used—which can be easily provided for in the case of low powers, but is rather impracticable with the higher numbers, it being very difficult to bring the prisms sufficiently near to the posterior combination of the objective. On the contrary, when the binocular arrangement is embodied *in the eye-piece*, the prism being once fixed in proper position, as before described, is correctly placed for every power of objective, and the eye-piece, thus binocular in form, is as applicable through the whole range of powers as if it were monocular. Applied to high powers, only one condition would be distinguishingly critical in the case of the eye-piece—that of the centricity of the central prism. The form of erecting *eye-piece* found most advantageous in this binocular adaptation is a duplication of the ordinary Huyghenian negative eye-piece, wherein the small dividing prism is very nearly at the eye-hole point of such a negative eye-piece as is ordinarily applied in the monocular Microscope. At a proper distance above this is placed another negative eye-piece, in which is formed a second image of the object viewed.

This form of erecting eye-piece gives less extension above the body of the Microscope than the positive form, and for that reason is preferred.

The annexed diagram (fig. 36) illustrates the division of pencils proceeding from the first image formed in the apparatus, and their general course to emergence at the two eye-surfaces. When the eye-piece is constructed of the form as here shown, the field is produced very satisfactorily, and of tolerable expansion; and does not necessitate more than 4·5 inches extension beyond the Microscope-body. The draw-tube can be as well withdrawn, and the eye-piece occupy its place, thus diminishing somewhat the total extent of the instrument. With proper modifications of the system of lenses placed before the prisms in the eye-piece, the whole binocular arrangement can be brought still nearer the objective, and retain also all the characteristics of the binocular eye-piece as contradistinguished from the binocular Microscope known and in use.

FIG. 36.

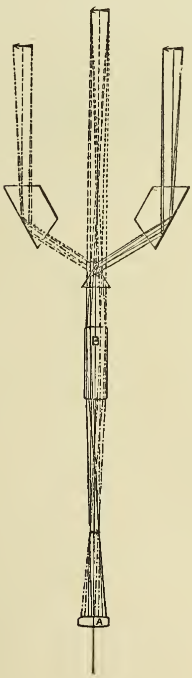
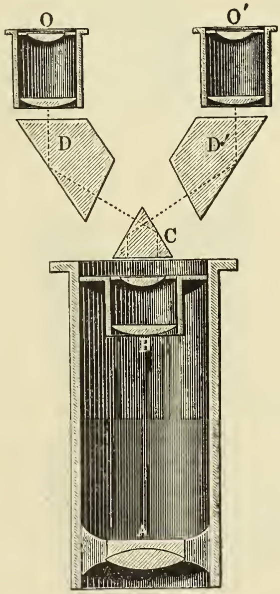


FIG. 37.



The objection that loss of light must occur on account of the additional front system of lenses pertaining to an erecting eye-piece (the lower system in the diagram), of course militates against the arrangement; but there are, on the other hand, incidental advantages in the use of the erecting form. . . . . As the object is for the sake of efficiency with a high-power objective, to give as large an area to the transmitted pencil as possible at the point where it undergoes division in the small prism, therefore the power of the front system should be kept down, and amplification, as far as necessary in the eye-piece, be produced after the division has taken place. . . . .

Having obtained by this means a pencil (or beam) transmitted through the eye-piece of the greatest possible dimension or area, at the point of binocular division, greater amplification in the eye-piece, as to its total power, might be advantageously effected by means of lenticular immergent and emergent surfaces of the upper prisms; the lower face of each prism to be *convex*, the upper emergent surfaces concave, giving achromatized refraction in each case. By this means a larger field, together with a minimum length of tubes above the prisms, would be secured.

By thus appropriating every surface of all the prisms not a reflecting surface, for the purpose of lenticular refraction, the greatest aggregate advantage appears to be secured."

We should mention that fig. 36 is not the diagram given with Mr. Tolles' original paper, but is one supplied by him shortly before his death, and drawn to scale, showing the path of the rays. In sending it, he remarked that without A the arrangement is a Nachet Binocular Microscope.

Fig. 37 shows one of the earlier forms of the instrument as combined with the eye-pieces, and is reproduced from Dr. Dippel's 'Handbuch der Allgemeinen Mikroskopie,' vol. ii. p. 598. Dr. Dippel points out that the eye-piece "either entails a very considerable lengthening of the body-tube or, if this inconvenience be avoided, considerably disturbs

FIG. 38.

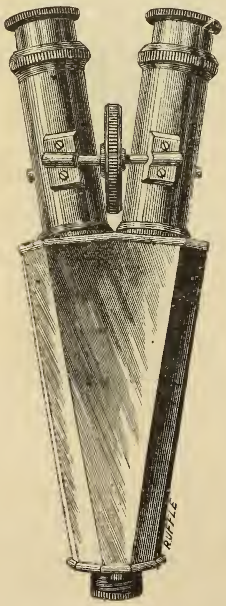
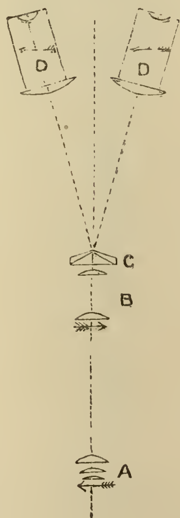


FIG. 39.

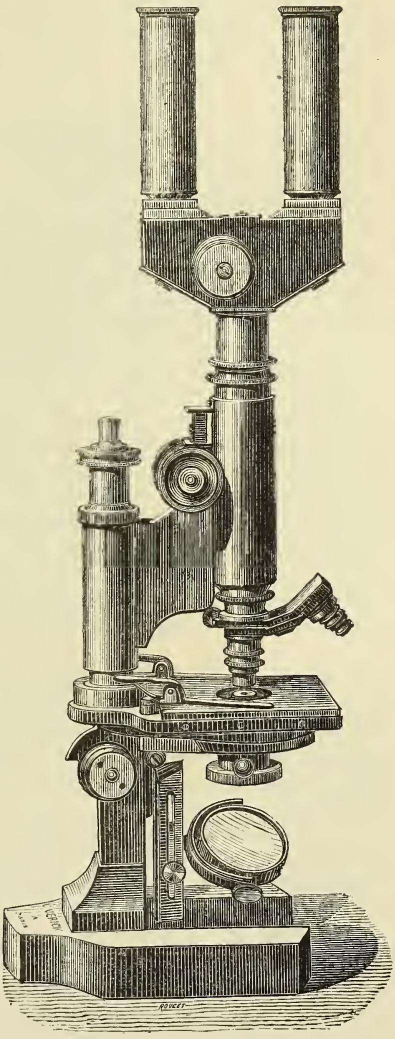


the optical effect of most objectives, because in this case they are used for a far shorter imaged distance, and consequently with an essentially different course of rays than in ordinary use."

Prazmowski's (figs. 38 and 39) is made entirely of brass, and being

of considerable size is inordinately heavy. A is the objective which forms an image near B, which is composed of two lenses, of which one is achromatic. This arrangement is essentially like a terrestrial or erecting eye-piece for a telescope, except that in the terrestrial eye-piece, the crossing-point (Ramsden circle) is *between* the component lenses, whilst in this binocular the crossing-point is situated higher up, in fact, just at the angle-edge of the achromatic prism C, where the pencil is divided. This arrangement gives a good field in each eye-piece. After division, the pencils pass on to the two eye-pieces D D, where they form images which are slightly unsymmetrical, by which the stereoscopic effect is obtained.

Fig. 40.



The diagram fig. 39 is from a drawing made for this Journal by the late A. Prazmowski.

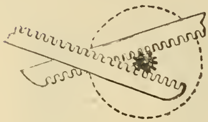
Vérick's (fig. 40) is, so far as its essential optical arrangement is concerned, identical with that of Tolles, *having a central equilateral prism and two truncated ones at the sides.* The erector is, however, an achromatic combination formed of a lower plano-convex lens and an upper biconvex one. The central equilateral prism is also mounted with its lower face in a brass ring, having a circular diaphragm about 1/4 in. in diameter immediately above the upper lens of the erector. To secure its exact orientation in relation to the truncated lateral prisms, the brass ring is made to rotate partially in the horizontal plane; a portion of the cylindrical edge of the ring being provided with a "worm" on which acts an endless screw that can be turned by a small key whilst the observer views the image.

Fig. 41 shows the mechanism by which the lateral prisms (with the eye-pieces) can be separated to suit the width of the observer's eyes. The sliding ebonite box-fittings in which they are mounted are attached respectively to the diagonal racked bars; the revolution of the toothed pinion (acted upon externally by the milled head shown by a dotted line

in fig. 41 and seen also in fig. 40), causing them to move exactly together outwards, or in the reverse direction.

A great advantage of the apparatus is that instead of being made of brass, and therefore very heavy, the eye-piece tubes are of aluminium, and the prism-box of ebonite; an admirably light eye-piece is thus obtained, which in that respect leaves nothing to be desired.

Fig. 41.



Hartnack also made some binocular eye-pieces, but we have not been able to obtain the materials for their description. Dr. Dippel gives * the following description of two of them, but his woodcut of the first, which he describes as having four Riddell prisms, is obviously not correct, as it figures an eye-piece like that of Vérick, which will not take the Riddell prisms.

"In the older Hartnack binocular, which is inserted into the Microscope-tube by means of an adapter, the duplication of the image and halving of the pencil of rays takes place in the course of the pencil between the objective and the position of the real objective image. Riddell's arrangement of four prisms serves for this purpose, the two eye-pieces being rigidly connected with the two prisms, which direct upward the twice totally reflected rays parallel to the axis of the Microscope. The adjustment of the eye-pieces to suit the eyes of the observer is effected by mechanism put in motion by a screw-head. More recently, Dr. Hartnack has constructed a somewhat more complex binocular eye-piece, which gives splendid images with a small field of view, and, as far as I could ascertain, agrees in principle with the Tolles apparatus, inasmuch as a prism, over a lens-system in the lower tube acting as eye-piece, divides the image into two erect images, which are observed through two ordinary eye-pieces converging below and movable by rack and pinion in the direction of their long axes."

(3) Illuminating and other Apparatus.

Screw Eye-piece Micrometers.—Much discussion has taken place in recent years on the subject of the relative accuracy of the different eye-piece micrometers, that is, between the fixed glass-plate micrometers on the one side, and the movable screw or spider's-web (filar) micrometers on the other.

In all these discussions the only screw-micrometer that has been referred to is the ordinary English form, with two spider lines, in which the optical part of the eye-piece is fixed immovably in the optic axis, while one of the spider lines traverses the field of view by the action of the screw. There are, however, some refinements of this apparatus to which attention may be called.

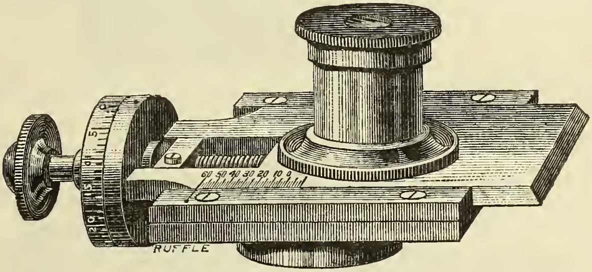
An important defect of the ordinary form of screw-micrometer arises from the fact that the measurements are not effected with the centre of the eye-piece alone, but use is made of the excentric parts of the lenses. The result of this is that the image of the object is subjected to more or less distortion, as its various parts are magnified differently, according

* L. c., pp. 598–9.

to their lateral distance from the optic axis. Harting found that the image of ten divisions of a glass micrometer gave a result 1/33 less when it was measured as a whole than when the single divisions were measured and added together. The difference in magnifying power of the different parts of the field of view can of course be determined, but the process would be very tedious, and is not practically available.

Dr. H. v. Mohl * therefore adopted the plan of moving the optical part of the eye-piece (with crossed threads) across the field. The image

FIG. 42.



is thus always observed only through the axis of the lenses, and the distortion found in the case of the ordinary micrometer is avoided. As will be seen in fig. 42, the tube containing the eye-lens and field-lens is attached to a slide which is moved by the screw so that the axis of the lenses may be displaced laterally in relation to the optic axis of the Microscope, or in other words, the eye and field lenses can be made to traverse the field of view. †

This micrometer, though it obviated the distortion caused by observation through the excentric parts of the eye-piece, gave rise to a some-

* Arch. f. Mikr. Anat., i. (1865) pp. 79–100.

† Fig. 42 does not represent Mohl's micrometer as described by him (of which, indeed, we believe no figure is extant), but is taken from one sent us by Messrs. Merz, the makers of his original form. One important difference is that in the latter the eye-piece is not attached directly to the slide moved by the screw, but to a second upper slide which can be moved on the first by hand. The object of this is to adjust the lenses in the optic axis at the commencement of an observation without having to use the screw for that purpose. (We should be glad to be referred to a drawing or photograph of Mohl's original form if it exists.)

The following is a condensed abstract of Dr. Mohl's original description :—

" As regards the mechanical details of the instrument constructed for Mohl by Steinheil, the Microscope-tube is screwed into a horizontal plate fixed on a solid standard, and carries a Fraunhofer screw-micrometer which works in agate bearings; above the micrometer is an orthoscopic Kellner eye-piece with a short tube. The eye-piece tube is not fixed directly to the micrometer-slide which is moved by the screw, but to a second slide which moves between swallow-tail guides upon the upper surface of the first in a direction parallel to the length of the micrometer-screw; this slide itself is moved by a second screw of deep pitch. The stage and condenser are separated from the body of the Microscope, being carried by a bar which can be fixed to the stand of the instrument by means of two short arms. The eye-piece therefore is movable not only by the micrometer-screw together with the slide which is used for measuring purposes, but also when desired by the second slide (or " eye-piece slide ") which moves horizontally upon the first, so that

what similar error of optical excentricity, the image observed by the eye-piece when not in the optic axis, being formed not by the central rays from the objective, but by the marginal rays. To obviate this

Fig. 43.

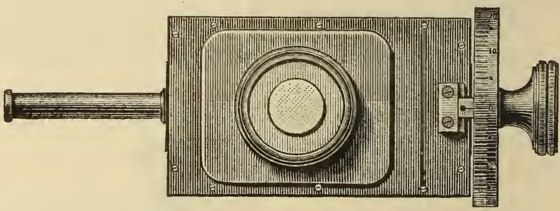
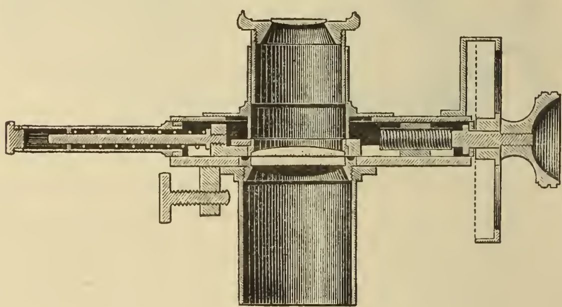


Fig. 44.



Prof. Abbe (see figs. 43 and 44) while making use of Mohl's device for moving the eye-piece across the field of view, added a second lens close

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it can be made to traverse the whole of the fixed microscopic image. It is important to have some means of readily bringing the eye-piece back to the axis of the Microscope, and of noting the positions of the micrometer and eye-piece slides which correspond to this adjustment. For this purpose three diaphragms were employed, each perforated with a minute hole; one is placed over the objective, one in the middle of the body-tube, and the third immediately under the eye-piece, so that they only transmit rays along the axis of the tube; by this contrivance the eye-piece can be adjusted in the axis by bringing it into the position in which the cross-wires exactly divide the small circular openings of the diaphragm into four equal quadrants; the position is then noted by marking an index line upon the eye-piece slide and one of its guides, and reading the micrometer-screw, so that it may at any time be at once recovered without a fresh adjustment. If it is required to use another part of the screw for measuring purposes it is only necessary to adjust the eye-piece to the axis, note the position of the cross-wires upon an object, and then after moving the screw to the desired point, to bring back the cross-wires to the same position by means of the eye-piece slide. In attempting to make a preliminary series of measurements Mohl found that in spite of the solid stand employed in his instrument and the massive plate to which the tube and micrometer were fixed, the pressure of the hand upon the micrometer-screw produced such considerable deflections in the instrument that it was impossible to make accurate adjustments, and it was only by fixing the tube to the stand by means of a rectangular framework of brass plates that it could be made sufficiently rigid."

beneath the field lens which remains immovable in the axis, while the field and eye-lens move over it. The lower plane surface of the field lens has diagonal cross lines, as well as a double index-mark engraved on it, and the plane upper surface of the additional lens has a scale. The lens has a focal length of about 17 mm., so that its lower focal point lies approximately in the opening of the objective, and the principal rays are made parallel in front of the eye-piece as if their centre of divergence was at infinite distance. In consequence of this, in every position of the eye-piece, the point of the field under observation behaves as the centre of the field of view in the ordinary arrangement, that is, *all* the pencils are identical with the axial pencil, and the shifting of the eye-piece produces no optical excentricity.*

Winkel's Combination of Screw-micrometer and Glass-micrometer Eye-piece.†—Dr. A. Koch writes as follows:—For fine microscopic measurements, in particular for the determination of the thickness of Bacteria, it appeared to me to be of advantage to possess an apparatus with which exact determinations could be made more easily than with the ordinary eye-piece micrometer. I found useful for this purpose an eye-piece with a thread such as has been in use for a long time in physical and astronomical instruments, and occasionally employed in Microscopes. In these eye-pieces a stretched thread or a mark on a glass plate can be moved parallel to itself by means of a micrometer-screw with divided head; for measuring, the thread is brought successively to both edges of the object, and its breadth is given by the number of turns of the micrometer-screw necessary to move the thread from one margin of the object to the other. The value of the divisions of the drum of the micrometer-screw is determined by an object-micrometer.

It is, however, inconvenient, especially with very strong magnifications and very small objects lying in great numbers in the field of view (such as Bacteria) to have to replace such a screw eye-piece by an ordinary micrometer eye-piece when it is desired to measure with less exactness the larger divisions of the object which we had previously been measuring with the screw eye-piece, e. g. the length of a *Bacterium*. Herr R. Winkel, of Göttingen, has, however, constructed a micrometer eye-piece in which the thread is replaced by a division on a glass-micrometer. This apparatus can therefore be used, as I have already mentioned in my work, 'Ueber Morphologie und Entwicklungsgeschichte einiger endosporer Bacterienformen,'‡ either as an ordinary micrometer eye-piece with fixed micrometer for less fine measurements, or for more exact determinations by using the micrometer-screw and successively adjusting one edge of a division on the margins of the object.

The mechanical details of the apparatus are shown in figs. 45 and 46, the latter fig. showing the internal arrangement after the upper part at A (fig. 45) has been unscrewed. In fig. 46 is seen the frame DE, which is moved by the micrometer-screw EF, which has a pitch of exactly 1/5 mm., and on which lies a glass micrometer divided in $\frac{10 \text{ mm.}}{100}$; the

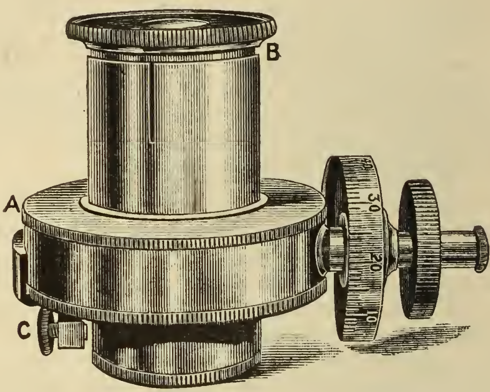
* Cf. Dippel's 'Handbuch der Allgemeinen Mikroskopie,' 2nd ed., 1882, pp. 639–40 (2 figs.).

† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 33–5 (2 figs.).

‡ Bot. Ztg., 1888.

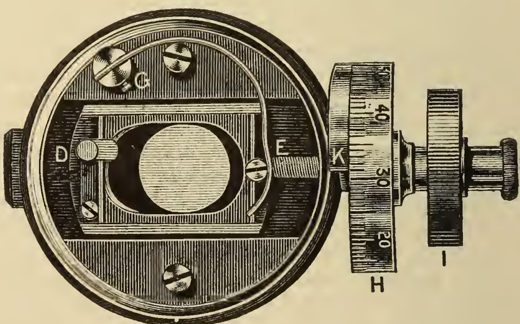
latter is held firm by the clamp at D, and on removing the upper part can be taken out for cleaning. Backlash of the micrometer-screw is completely avoided by the spring fastened at G, which extends to E.

Fig. 45.



On the micrometer-screw is the drum H divided into 100 parts, and the head I for clamping; the sharp end of the piece K screwed to the socket of the eye-piece serves as index. The upper lens of the eye-piece can be drawn out (B, fig. 45) for the exact focussing of the micrometer-

Fig. 46.



divisions. The whole is fixed to the body-tube by the screw C, though a slight shaking of the body-tube, owing to the movement of the micrometer-screw, does not injuriously affect the exactness of the measurements.

(5) Microscopical Optics and Manipulation.

On the use of Fluorite for Optical Purposes.*—Prof. E. Abbe has an article on this subject. Of the minerals which occur in nature, quartz and calc-spar are the only two which have been regularly used in

* Zeitschr. f. Instrumentenk., x. (1890) pp. 1–6.

practical optics. The great transparency of these minerals for violet and ultra-violet light has recommended them for spectroscopic purposes, but their chief use depends on the specific property of non-tesseral crystals of double refraction, by which results are effected which are not to be attained with an amorphous substance, such as glass. Tesseral crystalline minerals which, so far as their optical properties are concerned, are like glass, have already been made use of for optical purposes. Brewster and Pritchard, within the last forty years, recommended and employed the diamond and other precious stones of unusually high refractive power in Microscope lenses. Attempts in this direction, however, have brought no lasting gain to optics, and must at present be considered as wholly given up, the simple Microscope formed of uncorrected lenses being relegated to a subordinate use. Quite different points of view are now kept under consideration in judging of optical resources for the continued improvement of the compound Microscope. For, in face of the refinements which, in recent times, practical optics has kept in view, the estimation of the materials used in lens-combinations has altered in direction; it no longer looks at the greater or less perfection of its fundamental effect, which depends of course on the refractive power, but it has turned to the consideration of the degree in which the properties of these materials facilitate and advance the neutralization of the unavoidable subsidiary effects—spherical and chromatic aberration.

From this point of view a material which, from the standpoint of the efforts of Brewster and Pritchard, would appear very unprofitable, viz. fluor-spar, becomes of special interest at the present time for practical optics. This is because it offers unusual advantages in respect to the neutralization of those subsidiary effects. Fluorite possesses an abnormally low refractive power; the index for sodium light is only 1·4338, and is thus considerably lower than that of crown glass; its use as a constituent of a lens-system is therefore, in respect to the fundamental effect, relatively disadvantageous. However, with many lens-combinations, such as those used for the Microscope, there must be a difference of refractive indices between media in contact and with equal curvature of the bounding surfaces in contact to remove the spherical aberration; it is on the amount of this difference that the compensating effect in respect to the spherical aberration depends. The lower the index for the first medium, the greater the amount of this difference, and the more perfect the compensating effect which is to be attained by the addition of a second medium of given refractive power. So, also, the lower the index for the first medium, the lower that of the second, when a certain given difference is to be maintained. If, for example, in a cemented double lens—as used in the Microscope—an ordinary crown glass of index $n_D = 1 \cdot 52$ serves as the one member, and the removal of spherical aberration requires a difference of refractive powers of 0·20 on both sides of the cemented faces, then the above consideration shows that there must be connected with that crown glass a second lens with index 1·72, and consequently one made of a very heavy, strongly dispersive, flint glass. Supposing, on the other hand, the first member to be a lens of fluorite, then the required excess of refractive power of the second member would be given by an ordinary flint glass of 1·63, which for

many reasons would be much more advantageous. That mineral therefore affords greater convenience in the choice of the kinds of glass to be used in obtaining perfect compensating effects for the removal of the spherical aberration in lens-systems.

Besides this advantage, which gains special importance in the construction of Microscope objectives of large aperture, fluorite possesses the further useful optical properties of an abnormally low colour-dispersion, and a relation to the partial dispersions for the different parts of the spectrum which is very serviceable for the removal of the secondary spectrum. For the three hydrogen lines H_α, H_β, H_γ the differences of the refractive index are—

Material.	$N_\beta - N_\alpha$	$N_\gamma - N_\beta$	N_D.	$\frac{\Delta n}{n-1}$	$\frac{N_\gamma - N_\beta}{N_\beta - N_\alpha}$
Fluorite	0·00455	0·00255	1·4338	$\frac{1}{95 \cdot 4}$	0·561
Ordinary calc-silicate crown glass	0·00860	0·00487	1·5179	$\frac{1}{60 \cdot 2}$	0·566
Aluminium-phosphate crown glass	0·00737	0·00407	1·5159	$\frac{1}{70 \cdot 0}$	0·552
Borate flint glass	0·01026	0·00582	1·5521	$\frac{1}{53 \cdot 8}$	0·567

If the interval from H_α to H_β (C to F) be taken as a measure of the mean dispersion (Δn), the above table shows that the fluorite, not only taken absolutely, but also relatively to the value of $(n - 1)$, possesses a considerably lower colour-dispersion than the most advantageous glass hitherto produced; for while with the latter the so-called relative dispersion does not sink below 1/70, with fluor-spar it is diminished to 1/95. But the curvature which a compound lens of this medium must have in order to give an achromatic system of determined focal length when combined with a lens of greater relative dispersion, depends essentially on the amount of the relative dispersion of a medium. The smaller the $\Delta n / (n - 1)$ the less curvature suffices for achromatism under otherwise similar circumstances for a given focal length.

While thus a simple non-achromatic lens of fluor-spar, on account of its low refractive power, necessitates a much greater curvature for a determined focal length than one of crown glass, on the other hand, an achromatic lens with this material requires less curvature than one made of crown glass, supposing that the same flint glass is used for the compensation of the colour-dispersion.

Finally, the numbers in the last column of the above table show that the ratio of the partial dispersions in the two parts of the spectrum H_α to H_β and H_β to H_γ has for fluorite, in spite of its very low dispersion, almost the same value as for an ordinary silicate crown glass with dispersion 1/60. On the other hand, for the aluminium phosphate-crown, the most advantageous glass so far as the relative dispersion is concerned, the blue end of the spectrum is seen to be relatively

shortened, although the value of the $\Delta\, n\, /\, (n - 1)$ is only diminished to 1/70. Consequently fluorite may be said to offer special advantages for the simultaneous union of three rays of the spectrum, i. e. for the removal of the secondary colour-dispersion.

The above-mentioned phosphate crown glass, it is true, in combination with the above or a similar borate flint glass, also allows a direct achromatism for three different colours (not the three rays $H\alpha$, $H\beta$, $H\gamma$, yet three rays within the less refrangible part of the spectrum). It therefore serves for the construction of a double lens with only tertiary colours remaining; but in this combination the curvatures are somewhat disadvantageous. This is due to the fact that the numbers for the relative dispersion $\Delta\, n\, /\, (n - 1)$ in these two media—1/70 and 1/54—show only a slight difference. If, however, fluorite be substituted for the above crown glass, then a combination is obtained which satisfies the condition of the union of three different colours, and at the same time gives a very considerable difference of the relative dispersions of the two constituents (1/95 and 1/54). This difference still remains sufficiently large if the calc-silicate crown be substituted for the borate flint. The dispersion of this glass is, moreover, almost rigidly proportional to that of the fluorite through the whole visible dispersion. Accordingly, with these two media, a double achromatic lens of almost absolutely complete colour-union could be made; for there would be no tertiary spectrum remaining over. Having regard then to all the conditions which regulate the construction of a perfect lens-combination—the spherical aberration in systems of large aperture, as well as the chromatic aberration of first and second orders—fluor-spar affords more profitable relations than any material at present at our disposal in optics. The data on which the present conclusions are based, were made known long ago by the spectroscopic measurements on fluor-spar which Stefan published in the year 1871. The numbers given above are from the measurements of Dr. Riedel, of Jena, made in the year 1880 and later at the author's instigation, with the use of hydrogen lines, on different varieties of the mineral. They agree with the values found by Stefan within the limits of errors of measurement, so far as they concern the same parts of the spectrum. The characteristic optical properties of fluor-spar shown by these spectroscopic measurements are doubtless due to the specific effect of the fluorine which makes up fifty-six per cent. of the calcium fluoride. It might therefore be reasonably expected that if it were possible to introduce this element in considerable quantity into artificial fusions, kinds of glass would be obtained which, partially at least, would exhibit the valuable peculiarities of fluor-spar.

Experiments made in this direction by Dr. Schott in 1881 and the following year in the course of his work on the improvement of optical glass have to a certain extent realized that idea. By the use of fluorides in small quantity glasses were produced which, with lower refractive index, exhibited also a very diminished dispersion. These experiments, however, showed clearly at the same time (as Dr. Schott has already indicated) the extraordinary technical difficulties which stand in the way of the production of sufficiently homogeneous glass of such a composition. These difficulties at first appeared to be so great that it seemed

to be impossible to prepare practically useful kinds of glass with similar properties to those of fluor-spar.

This result has served to fix the author's attention on the use of the natural mineral for purposes of practical optics, and more especially for Microscope objectives; for previous experiments in the year 1881 had already shown that fluorite, in spite of its less hardness, is susceptible of being shaped like glass, although with some difficulty.

By using clear crystals and cleavage fragments, such as were then easily obtainable from mineral dealers, in the year 1884 the optical factory of Carl Zeiss in Jena first constructed, under the author's direction, Microscope objectives of different kinds, in which perfect correction of the spherical and chromatic aberration was effected by the use of lenses—one to three in each system—of fluorite instead of crown glass. With the introduction of the new Microscope objective, the "Apochromatic," the mineral has come into regular use in Jena, and has been further extended by other opticians in their imitation of the Zeiss construction. The calculations and technical details of these constructions have been rendered much easier by the introduction of fluor-spar in partial replacement of crown glass. Without its aid those lens-systems, for the same requirements in the construction, would have been still more complicated in composition, and more difficult in manufacture than they are at present.

In view of this use of fluorite for the Microscope now generally admitted, and considering the advantages which it offers for many other purposes of practical optics, it will be of interest to discuss the determining condition of its use, viz. the possibility of procuring this material in sufficient quantity and quality.

The inquiries which the author set on foot many years ago have hitherto led to no satisfactory result. Fluor-spar belongs, it is true, to the widely distributed minerals, and is found in very many places in transparent crystals. Most varieties, however, apart from the rarity of large clear pieces, are quite worthless for optical purposes. This is due to the fact that they show double refraction in a marked degree and owing to disturbances of the regular crystal growth. Until some years ago, tolerably large pieces, which were water-clear and in parts quite pure, could be obtained from mineral dealers. These were attributed to different, though principally Swiss, localities, and it seemed reasonable to suppose that this serviceable variety, free from double refraction, would be of quite general occurrence and consequently not difficult to procure. More exact inquiries, however, soon proved that all such specimens of fluorite, met with amongst dealers or in collections, are referable to one and the same locality in the Schwarzhornstock in the Bernese Oberland, and in fact, to a single find accidentally made there almost sixty years ago.

According to the communications of Herr E. v. Fellenberg, of Bern, and to information which the author obtained later at the place itself, a hole, out of which was obtained considerably more than 100 cwt. of large water-clear crystals and cleavage pieces of fluor-spar, was discovered above the Alp Oltscheren by Alpine shepherds from Brienzwyler, near Brienz, in the year 1832. This material was distributed amongst dealers in minerals in all directions, and after

dealers, collectors, and museums had been supplied, was sold by the owners to chemists for the preparation of hydrofluoric acid, or thrown away as worthless. A part is said to have come to Paris fifty years ago, and to have been used by opticians in lenses and prisms for experiments on heat radiation. The remnants presumably of this remarkable find, which included some water-clear crystals (cubes) as large as one's head, hidden away in cellars, &c., were purchased by the author in the preceding year from the grandchildren of the original finders, and were thus saved for optical purposes.

The precise locality of that old find had been forgotten. By means of the labels, however, found in the Bern Museum, Herr v. Fellenberg, who has assisted the author in these inquiries in the most friendly way, was enabled to fix it as the south-west slope of the Oltschihorn, the offshoot of the Schwarzhornstock towards the Lake of Brienz.

Chance investigations made with the help of some Oberland crystal-seekers proved the frequent occurrence of fluor-spar in the neighbourhood, but the old locality was not discovered, nor was further material with the characteristics of the earlier find obtained. The firm of Carl Zeiss therefore took up the quest, and during the summer of this and the preceding year caused regular excavations to be made by a large number of practised workmen under the direction of an agent. By this means, in July 1888, on a steep, almost inaccessible rock about 1900 metres above sea-level, the hole was discovered out of which came the find of 1832. It was found, however, to be practically exhausted. Further investigation of the mountain which—belonging to the upper Jura—is distinguished by massive schist formations with numerous precipices, fissures, and cavities, was then made. In this way semi-transparent calc-spar and fluor-spar, crystallized in large cubes, but so far as purity was concerned in no way comparable with that found in the old locality, were discovered in several places near that spot. Of several hundredweight collected, only some pounds were clear and suitable for optical purposes. In August of the present year the work was therefore discontinued, after all traces found by blasting had been followed up as far as they gave any indications of better results. It therefore appears beyond all doubt that the single locality which formerly afforded fluor-spar in large clear masses is now completely exhausted.

The employment of the mineral for Microscope lenses is hardly affected by this; for the comparatively small quantity required for this purpose is assured by the general occurrence of less perfect material, from which, with some difficulty, it can be picked out. On the other hand, the further extension of its use in optics will be dependent in every way on the discovery of new localities which afford large crystals or cleavage-masses of similar purity to that which was formerly found at Oltschihorn.

Perhaps this communication may help to make this mineral, so valuable to optics, an object of greater attention, and possibly to bring to light localities of it which have hitherto remained unnoticed.

J. M. M. writes,* in reply to a correspondent "Prismatique," "'Fluorite' is simply the Continental name for common fluor-spar, and,

* Engl. Mech., li. (1890) pp. 205-6.

doubtless, if he will visit any of the Derbyshire spar or lead mines—for the mineral is a constant companion of lead veins—he will find crystals of it quite fit for optical work in overwhelming quantities. Perfectly colourless crystals are certainly not very common, neither are they very rare; but, at the same time, are they necessary? The most common colour the mineral assumes is a pale green, evident enough in large crystals; but in laminæ thin as the lenses of an objective, scarcely, if at all, perceptible.

'Prismatique's' experience of the deterioration of the new glasses from atmospheric influences is valuable. It is, at the same time, just what a chemist would expect from the composition of some of them, that is, if they are honestly named. It must not be forgotten that more than half a century ago our own Faraday in England, and Amici, in Italy, produced new glasses for optical work which possessed valuable properties, and offered great advantages, optically, over those in common use. Ross, in London, and Chevalier, in Paris, worked Microscope objectives from the new glass, and their performance was said to be a great advance upon that of lenses made from the ordinary material. It was, however, found that they deteriorated so rapidly that their manufacture was given up.

I have now in my possession a 1/10 in. made by Chevalier. The outer lenses of the combination, viewed by reflected light, are a bright steel-blue in colour, much like the screw-heads in a watch movement. The performance must have been phenomenal at the date of its production, for it will even now "dot" *angulatum*; but the field is filled with fog produced by the action of the decomposed surfaces upon the light, analogous in effect, but less in degree, to that produced by a very finely ground but unpolished lens. With this experience behind us, precisely equivalent to that of 'Prismatique' with the new glasses, it behoves one to pause before rushing to the conclusion that the optical millennium is here."

Mr. Lewis Wright writes * on the same subject in reply to some strictures by 'Prismatique' on the Jena glass and German opticians. "Apart from fluorite altogether, great improvement has been made by English and other opticians with the new glass alone; and German micro-objectives are now reaching this country superior to any made here at double the price. I speak from personal trials, of which I may perhaps say a few words another time. Zeiss undoubtedly used at first glass which would not bear exposure to the air; but these things were gradually discovered and remedied, though it is too soon yet to say if even present lenses will stand permanently. I believe I was, myself, the very first to utter a word of caution in these columns on that very point, though a glass may be useful in the middle of a triplet which will not stand atmospheric exposure."

Jena Glass.†—Mr. A. Caplatzi thinks it will be of interest to give the list published in 1888, which brings the variety of glasses up to 63.

The first column contains the number, the second the factory number, the third the description, the fourth the refractive index for D, the fifth the medium dispersion C to F, and the sixth the specific gravity. At a

* Engl. Mech., li. (1890) p. 222.

† T. c., p. 117.

little enhanced price pressed discs of the same glass having the approximate form of the desired lens can be obtained.

No.	Fabric No.	Description.	Refractive Index D.	Medium Dispersion, C–F.	Specific Gravity.
45	0·599	Boron silicate crown	1·5069	0·00813	2·48
46	0·337	Silicate crown	1·5144	0·00847	2·60
47	0·374	" "	1·5109	0·00844	2·48
48	0·546	Flint crown	1·5170	0·00859	2·59
49	0·567	Silicate crown	1·5134	0·00859	2·51
50	0·610	Crown of low dispersion ..	1·5063	0·00858	2·51
51	0·598	Silicate crown	1·5152	0·00879	2·59
52	0·512	" "	1·5195	0·00886	2·64
53	0·463	Baryta light flint	1·5646	0·01020	3·11
54	0·608	Crown of high dispersion ..	1·5149	0·00942	2·60
55	0·602	Baryta light flint	1·5676	0·01072	3·12
56	0·381	Crown of high dispersion ..	1·5262	0·01026	2·70
57	0·583	Baryta light flint	1·5688	0·01110	3·16
58	0·543	" "	1·5637	0·01115	3·11
59	0·527	" "	1·5718	0·01133	3·19
60	0·575	" "	1·5682	0·01151	3·15
61	0·522	" "	1·5554	0·01153	3·03
62	0·578	" "	1·5825	0·01255	3·29
63	0·376	Ordinary light flint	1·5660	0·01319	3·12
64	0·340	" "	1·5774	0·01396	3·21
65	0·569	" "	1·5738	0·01383	3·22
66	0·318	" "	1·6031	0·01575	3·48
67	0·266	" "	1·6287	0·01775	3·72
68	0·335	Dense silicate flint	1·6372	0·01831	3·77

Lehmann's Molecular Physics.*—The following review of Dr. Lehmann's treatise is taken from a recent number of 'Nature,'† where it appeared under the title of "The Application of the Microscope to Physical and Chemical Investigations":—

Very soon after the first invention of the Microscope, attempts were made to apply the new instrument to solve some of the remarkable problems of crystallogenesis. The early volumes of the Royal Society Transactions contain in the papers of Boyle, Hooke, and Leeuwenhoek, published between the years 1663 and 1709, many records of attempts of this kind; and the works of Henry Baker, which appeared between 1744 and 1764, are also largely concerned with the study of the process of crystallization under the Microscope.

In Germany, Ledermuller in 1764, and Gerhardt in 1780, showed the value of the Microscope in studying the internal structure of crystals; while in France a long succession of enthusiastic investigators, Daubenton, Dolomieu, Fleurian de Bellevue, Cordier, and others, were busily engaged in laying the foundations of the science of microscopical petrography.

Early in the present century, we find the English investigators once

* 'Molekularphysik, mit besonderer Berücksichtigung mikroskopischer Untersuchungen und Anleitung zu Solchen, sowie einem Anhang über mikrochemische Analyse.' Von Dr. O. Lehmann, Professor der Electrotechnik am kgl. Polytechnikum zu Dresden. Leipzig (W. Engelmann), 1888–9, 2 vols., pp. 852 and 697 (624 figs. and 10 pls.).

† Nature, xlii. (1890) pp. 1–2.

more taking a leading part in applying the Microscope to the study of crystallized bodies. Between the years 1806 and 1862, Brewster published a long series of memoirs, dealing with the microscopical characters of natural and artificial crystals, and the inclusions which they contain. About the year 1850, too, Mr. Sorby commenced his important investigations on the subject, availing himself of the method of preparing transparent sections of rocks and minerals which had been, shortly before this time, devised by William Nicol. Mr. Sorby's epoch-making memoir, "On the Microscopical Structure of Crystals, indicating the Structure of Minerals and Rocks," made its appearance in 1858.

While one group of investigators, following the lines of the early work of Brewster and Sorby, have sought to make the Microscope an efficient instrument for the determination of minerals, even when present in rocks as the minutest crystals or fragments; others have no less diligently pursued the methods which the same pioneers in this branch of research have initiated for solving physical and chemical problems connected with the formation of crystallized bodies.

In the hands of Des Cloizeaux, Tschermak, Zirkel, Von Lasaulx, Fouqué and Michel-Lévy, Rosenbusch, and other workers, the Microscope has gradually been developed into a splendid instrument of mineralogical research; and the determination of the minutest particles of a mineral is now becoming no less easy and certain than that of the largest hand-specimens.

But, at the same time, Brewster and Sorby's early attempts to solve physical and chemical problems by the aid of the Microscope have not failed to exercise an important influence on subsequent workers in these branches of science. Link, Frankenheim, Klocke, Harting, and especially Vogelsang (whose early death was a severe loss to this branch of science), have done much towards establishing the science of crystallogenesis upon a firm basis of accurate observation; and their labours have been continued in more recent times by H. Behrens and Dr. Otto Lehmann, the author of the work before us.

As the well-known treatises of Rosenbusch, and of Fouqué, Michel-Lévy, and Lacroix give us an admirable *résumé* of the present state of determinative mineralogy, as improved by the application of the Microscope, so does the work before us contain a perfect summary of the contributions of the microscopist to the sciences of physics and chemistry.

It will only be possible, within the limits of an article like the present, to indicate briefly the plan of the very comprehensive and, indeed, almost exhaustive work, in which Dr. Lehmann has embodied the observations of himself and his predecessors in this field of inquiry.

The first division of the book deals with the construction and use of the Microscope; especial attention being given to forms of the instrument, like those devised by Nachet and by the author of this work, for the special purpose of studying crystallization and other physical and chemical processes.

The second division of the book treats of those physical properties of matter which are presented by all bodies, whether in the solid, liquid, or gaseous state. Such questions as the polarization and absorption of light, the conduction of heat, and the electric and magnetic relations of various substances are here dealt with by the author.

The next division relates to the peculiar properties presented by solids. Elasticity and plasticity are considered, and, under the latter head, the remarkable phenomenon of the production of twinned structures in crystals by mechanical means is fully discussed. Under the head of cleavage we find a treatment of such phenomena as the production of mathematical figures in certain crystals by pressure, percussion, &c.; while under the heads of "Enantiotropie" and "Monotropie" are classified the consequences which follow from heteromorphism among crystalline substances, and the tendency of the heteromorphous forms to pass one into the other.

The division dealing with liquids and their peculiar properties contains discussions on fluidity, surface-tension, diffusion, capillarity, and crystal-growth, with the origin of structural anomalies. The problems of solution and precipitation, with those of solidification and fusion, are also treated of in this part of the treatise.

The second volume of the work commences with the discussion of the properties of gases and their relations to solids and liquids. This division of the subject, which is very exhaustively treated, extends to 335 pages.

The work concludes with critical remarks upon different molecular theories. The chapters dealing with the theories of crystal structure, of allotropy, of heteromorphism, and of isomerism, with several others, in the same division of the book, are full of interest and suggestiveness.

A supplement of about 150 pages is devoted to what the author calls "crystal-analysis," or what is generally known to geologists and mineralogists as "microchemical analysis." Very minute particles of an unknown substance may often be determined by being treated with appropriate reagents and studied under the Microscope; in this way they are made to yield crystals of various compounds which can be recognized by their characteristic forms and habit. An admirable summary is given by the author of the work of Bôricky, Streng, Behrens, Haushofer, and others, who have gradually perfected this branch of research, and made the method one which is of the very greatest service to the students of microscopical mineralogy and petrography.

While the physicist and chemist will find in this work a perfect mine of interesting and ingenious experiments (many of which are suited to class-demonstrations by projection methods), the mineralogist and geologist will hail the appearance of the book as one that completes and supplements the well-known treatise of Vogelsang—a work that has exercised the most important influence on the development of petrological theory.

In conclusion, it may be pointed out that, not only are the numerous observations of the author on crystallogenesis that are described in memoirs in 'Groth's Zeitschrift' included in the work before us, but many others that have never before been published find a place in these volumes. The work is very fully illustrated both with woodcuts and coloured plates, and constitutes a complete synopsis of all that is known on a number of questions of great importance and interest to workers in many different branches of science.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Foureur, A.—**Étude sur la culture des Microorganismes anaérobies.** (Study on the culture of anaerobic micro-organisms.)
Paris (Doin), 1889, 8vo, 73 pp. and 25 figs.

Jeffries, J. A.—**A new method of making Anaerobic Cultures.**
Med. News, 1889, p. 274.

(2) Preparing Objects.

Study of the Embryology of the Earthworm.†—Mr. E. B. Wilson says:—"After testing many different hardening fluids, I have found none to compare with Perenyi's fluid, which gives uniformly the best results, both for sections and for surface-views of all stages, and is far superior to picro-sulphuric acid or corrosive sublimate. Flemming's mixture of osmic, chromic, and acetic acids gives very clear differentiation of the middle stratum of the germ-bands after staining with hæmatoxylin, but in most respects it is far inferior to Perenyi's fluid. The embryos were left in the fluid from 15 to 60 minutes, placed in 70 per cent. alcohol for a day, and kept permanently in 90 per cent. alcohol.

For permanent staining no method has proved so satisfactory as borax-carmine followed by hæmatoxylin. After being deeply stained in the carmine (12 hours), and extracted in acid alcohol in the usual manner, the embryos were treated with extremely dilute ammoniacal alcohol for a few minutes, to neutralize the free acid, and were then stained in very dilute Kleinenberg's hæmatoxylin (12 hours or more). In case of overstaining with hæmatoxylin, the colour may be again extracted with acid alcohol, after which the specimens are again treated with ammoniacal alcohol. This process, following treatment with Perenyi's fluid, gives beautifully clear preparations, which are specially favourable on account of the clearness with which the cell-outlines are shown. It has been found desirable to imbed the specimens for sectioning as soon as possible after hardening, and to reduce the time of immersion in melted paraffin to a minimum (i. e. not more than 10 or 15 minutes).

For surface-views of the germ-bands the borax-carmine stain should be very deep, and the hæmatoxylin very slight, so as to give the specimen only a purplish colour, not a dark-blue. The germ-bands are dissected off on the slide, in strong glycerin. This method has, in my experience, given far better results than that of osmic acid followed by Merkel's fluid, so successfully used by Whitman in the study of *Clepsine*.

For the study of entire specimens of the young stages I have found Perenyi's fluid, followed by alcohol, water, very dilute iodine solution, and glycerin, to give results superior beyond comparison to those attained by any other method. The iodine colours the protoplasm pale yellowish-brown, the cell-outlines are clearly marked, and the nuclei are stained deep brown. In time, most of the iodine is precipitated in the form of deep-brown spheres, which mar the clearness of the preparations, but

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Journal of Morphology, iii. (1889) pp. 445–6.

such specimens may be afterwards stained with carmine, &c., sectioned, and mounted in balsam in the usual manner, and give perfect satisfaction, even after a stay of two years or more in the glycerin."

Experimental Imitation of Protoplasm.*—Prof. O. Bütschli has communicated to Prof. Ray Lankester a full account of the methods by which he attempts to imitate protoplasm.† A medium-sized watch-glass or flat dish must be filled with a thin layer of common olive oil and be placed on a water-bath or small cupboard at a temperature of about 50° C. The great point is to select the right moment at which the oil attains the proper degree of thickness and viscosity; this moment can, however, only be found by systematic trials. After three or four days a trial may be made. Should the drop not have become finely vesiculate and exhibit little or no streaming, the heating process must be continued and a trial made on the succeeding day. If the oil becomes too thick it will form frothy drops, and in such cases a small quantity of ordinary olive oil must be mixed with it.

The vesiculate drops are prepared thus:—In a small agate mortar a small quantity of dry carbonate of potash is ground to a fine powder. This must be breathed on till the salt becomes slightly moist, and then a drop of oil must be added; the two constituents should be mixed till they form a thickish paste. A few drops of it, about the size of a pin's head or smaller, are placed on a cover-glass, the corners of which are supported by small pegs of soft paraffin. Prof. Bütschli then places on a slide a drop of water, and puts the cover-glass over it in such a manner that the drops of paste are immersed in the water, but are not much compressed. The preparation is then placed in a damp chamber, and remains there about twenty-four hours, when the drops have a milk-white and opaque appearance. The preparation is then well washed out with water, which is supplied at one edge by a capillary tube and drawn out by blotting-paper at another.

If the drops have turned out well they will begin almost at once to move about rapidly and change their shape continuously. The water under the cover-glass must now be displaced by glycerin diluted with an equal bulk of water, when a vigorous streaming movement will be exhibited. The amœboid movements are generally more distinct if the drops are somewhat compressed. If the drops do not stream they can generally be made to do so by tapping the cover-glass slightly, by applying gentle pressure, or sometimes by breaking up the drops. It is especially interesting to see how fast and beautifully the drops creep to and fro in the water or in half-diluted glycerin, even when they are not compressed. The streaming movement, on the other hand, is better seen if the drops are somewhat compressed; this may be done by inserting under the cover-glass a piece of broken cover-glass of medium thickness, and then removing the paraffin pegs. This streaming movement is best demonstrated twenty-four hours after the addition of the glycerin, as the drops will then be thoroughly cleared and transparent. The movement and streaming are much more marked and distinct if the drops are examined on a stage warmed to 50° C.

* Quart. Journ., Micr. Sci., xxxi. (1890) pp. 99-103.
† See this Journal, 1889, p. 731.

Prof. Bütschli adds:—"You must not doubt the correctness of the phenomena which I have described if the first trials do not give the desired results."

The student may also be referred to the account given by M. Yves Delage * of his experiences in Prof. Bütschli's laboratory at Heidelberg.

Method of Examining Network of Muscle-fibres.†—Mr. C. F. Marshall adopted a modification of Mays' method of demonstrating nerve-endings in muscle. Mays used a mixture of 20 parts arsenic acid (1/2 per cent.), 4 parts gold chloride (4 per cent.), and 1 part osmic acid (2 per cent.), but this, while preserving the nerve-endings, disintegrates the muscle-fibre by the action of the arsenic acid. Mr. Marshall, after several experiments, used 20 parts acetic acid (1 per cent.), 4 parts gold chloride (1 per cent), and 1 part osmic acid (1 per cent.). The muscle-fibre was placed in this solution for fifteen minutes after previous immersion in acetic acid (1 per cent.) for a few seconds; then in acetic acid (1 per cent.) again in a warm chamber for one or two hours.

Mounting Spermatozoa of Salmonidæ.—Mr. F. M. Walford, at the meeting on April 16th, said:—"Having occasion lately to examine the spermatozoa of the English brook trout (*Salmo fario*) and the American trout (*S. fontinalis*), I found it would be advantageous to have permanent mounts at my disposal. Mr. E. M. Nelson has suggested that the communication to the Royal Microscopical Society of a brief note descriptive of the method adopted might be of assistance to students of this branch of science.

The collection of the milt containing the spermatozoa flowing from a spawning fish presents no difficulties when a medium is used which will preserve the spermatozoa without coagulating them. Alcohol or acetic acid, even when dilute, coagulate the milt, and should be avoided. One part glycerin to five of water is a fairly good medium, but the aqueous solutions of phenol or corrosive sublimate of about $2\frac{1}{2}$ per cent. are preferable.

The majority of text-books recommend glycerin and water for mounting spermatozoa, and hence this was one of the first media tried, but the resolution, even with 1/12 oil-immersion, was most unsatisfactory. The result of a number of experiments in staining may be summed up in the statement that the effect of staining is to make the heads more prominent and the filaments less visible. Specimens collected in $2\frac{1}{2}$ per cent. and mounted in $1\frac{1}{4}$ per cent. solution of corrosive sublimate looked fairly well for a time, but after a few months the heads of the spermatozoa gradually dilated and showed signs of disintegration.

A suggestion was made that, as probably a medium of low refractive index was desirable, it might be practicable to mount the spermatozoa dry on the cover-glass. So far I have not succeeded in doing so, but future experiments in this direction may be productive of better results. I was told by a friend that at one of the hospitals Farrant's medium was used for human spermatozoa, and the idea occurred to me that, as working in Farrant often produced where not desired a plentiful crop of air-bubbles, it might be possible to take advantage of this peculiarity and show the

* Arch. Zool. Expér. et Gén., v. (1889) pp. xliii.–xlviii.

† Quart. Journ. Micr. Sci., xxxi. (1890) pp. 73–4.

spermatozoa in the air-bubbles on the surface of the Farrant. The *modus operandi* is as follows:—A drop of Farrant is placed on the slip. A small quantity of the spermatozoa in $1\frac{1}{4}$ per cent. corrosive sublimate is dropped from a pipette on the Farrant. The cover-glass is lowered horizontally on to the spermatozoa, and if there are no air-bubbles visible to the naked eye, the cover-glass is lifted and again allowed to fall flat on the spermatozoa. The superfluous fluid is drawn from the edge of the cover-glass with a piece of blotting-paper. The mount is placed in a drying cabinet for some hours until the Farrant is set quite hard, and is then secured by two coats of Hollis."

Methods for making Permanent Preparations of Blood.*—Dr. U. Rossi communicates two methods by means of which he obtains permanent preparations of blood. (1) In a glass vessel is prepared a strongish and recently filtered solution of methyl-green. Another vessel is filled with one-third distilled water, one-third osmic acid (1 per cent.), and one-third of the foregoing solution. The mixture should be quite clear, and of an emerald-green colour. One drop of this mixture, which is at the same time fixative and staining, is placed on a slide. Then a glass rod just smeared with the staining solution is dipped in the heart's blood of a recently killed animal, and this drop of blood mixed with the drop of the methyl-green solution on the slide. The preparation, protected from dust, is left in a moist atmosphere for about half an hour. At the end of this time the preparation is treated with a minute drop of acetic acid, all the various ingredients being carefully mixed together with the quill-point which has carried the acetic acid. The preparation is then covered over, and glycerin in very small drops placed along the edge of the cover-glass, under which it slowly runs.

(2) Blood obtained directly from the heart of some small mammal is allowed to fall into a watch-glass containing osmic acid of $1-1\frac{1}{2}$ per cent. The mixture having been well shaken up, is poured into a little tube and left for 24 hours. At the expiration of this time the blood is deposited at the bottom, and the osmic acid is then siphoned off or removed by means of a piece of cotton thread, one end of which dips into the fluid, but so as not to touch the blood, and the other into an empty tube. When the acid has been removed the blood is washed two or three times with distilled water, this being removed in the same way as the acid. The blood is then stained with alum-carmine to which has been added acetic acid in the proportion of 1 per cent. by volume of the carmine solution. The blood is then washed again, and next treated first with rectified spirit and afterwards with absolute alcohol. A drop of this blood is removed with a pipette to a slide, and when the spirit has evaporated is treated with carbol-xylol and then mounted in dammar.

Effect of Galvanic Current and other Irritants on Protista.†—Dr. M. Verworn, in studying the effect of galvanism upon certain

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 475–7.

† Pflüger's Archiv f. d. Ges. Physiol., xlv. (1889) pp. 1–36 (2 pls. and 6 figs.); xlvi. (1889) pp. 267–383 (3 pls. and 5 figs.). 'Psycho-physiologische Protisten-Studien,' Jena, 1889, 8vo, 220 pp. and 6 pls. Cf. Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 496–50 (3 figs.).

Protista, employed the following apparatus. The fluid containing the organisms was placed in a rectangular cell, the long sides of which, composed of porous clay, were from 1–5 mm. thick and 20 mm. long, the shorter ends being composed of a cement made of a mixture of wax and resin. To the clay sides or electrodes were applied the brush electrodes. These were short glass tubes, closed at one end with clay and filled with a saturated solution of zinc sulphate. From the plug projects outward the brush, while at the other end projects inwards a zinc rod connected with the wires. Sometimes the extremities of the electrodes were made of porous clay and cemented down to the slide, so that their points were immersed in the fluid. The current was produced from a chromic acid battery of twelve elements, the cells of which were 17 cm. high and 11 cm. broad.

In this way the author found that various species responded differently to the two kinds of stimulus, some being affected by the positive current and others by the negative.

By the use of the porous points instead of brushes it was found that the galvanotropic effect was not confined to a small area near the electrodes, but was actively efficient even in vessels of 10 ccm. contents over the whole mass of water. Hence the action tended to collect the organisms into aggregations. For example, in the same water Flagellata would accumulate about the anode, the Ciliata about the kathode.

When the movements of Protista are to be studied to ascertain the influence of light, it is important to remove all sources of disturbance. If a large drop of water should be used, the Microscope must be quite horizontal, oblique light must be cut off by surrounding the slide with black paper, and the warming power of the transmitted light obviated by the interposition of a layer of ice between the mirror and the slide. The Protista may then be examined either by placing them under the Microscope with all the just-mentioned precautions, and with the addition of first covering the mirror with black paper. The paper is then suddenly withdrawn, and the movements observed. Or a drop of water containing the organisms is placed on a cover-glass coated on the other side with black paper, in which a window 3 mm. square has been cut. The effect of coloured light can be observed by interposing solutions such as ammonia, copper, and bichromate of potash.

The effect of warmth can be studied in a similar way, that is, by means of first covering the mirror and observing the movements through the window of the cover-glass. It is of course necessary to first ascertain the degree of heat by previously focussing the light on a thermometer.

The effect of mechanical irritation was ascertained by shaking the slide either once or frequently. The continued vibration was attained by fixing one end of the slide and moving the other end up, and then allowing it to drop by means of a toothed wheel of four cm. diameter, and with the teeth 1 cm. apart.

In addition to the foregoing, the effects of local, acoustic and chemical irritants were also examined.

The behaviour of small pieces as compared with uninjured organisms was also observed. The pieces were obtained by crushing or cutting with a knife made by sharpening a needle into a blade.

Effect of Hardening Reagents on Nerve-cells.*—Dr. E. Sehrwald calculates that the large cells of the central nervous system become shrivelled to the extent of 21–26 per cent., owing to the effect of the hardening fluids necessary for producing Golgi's staining. The shrivelling is accompanied by warping, a result induced by the fibres and processes from the cells being incrusted with metallic salts. From the warpings and curves produced in the fibres, the author makes his calculation as to the diminution in size of the cells.

Staining and permanent Preservation of Histological Elements, isolated by means of caustic potash or nitric acid.†—Mr. S. H. Gage and Mrs. S. P. Gage point out the methods of checking completely the action of KHO and HNO^3 at will, so that the isolated elements may be permanently preserved in alcohol or glycerin, and also stained in the usual way.

30 to 50 per cent. solutions of caustic potash act with great rapidity on intercellular substance, and quite slowly on cellular elements, while weak solutions rapidly dissolve all the elements. The action of the strong solution may be checked at any time by means of a 60 per cent. solution of potassium acetate, or by the addition of sufficient glacial acetic acid to neutralize the caustic potash and form acetate of potash. Either fresh or hardened tissue may be used. The pieces should not exceed half a cubic centimetre in size, and fifteen to twenty times as much potash solution should be used as tissue. As soon as the elements separate readily the caustic potash solution should be poured off and replaced by a copious supply of a 60 per cent. solution of acetate of potash, to which one per cent. glacial acetic acid has been added. The isolated elements may be mounted in acetate of potash, in glycerin, or in glycerin-jelly. If the elements are to be stained, they must be soaked for twenty-four hours or more in a saturated aqueous solution of alum. They are then stained with hæmatoxylin, or alum-carmine.

Nitric acid is used in 20 per cent. solution, and the time required varies with the temperature. At the ordinary temperature, one to three days are required. If heat be used, the action may be completed in a few minutes. The action of the acid is suspended by immersion in water until the acid is quite removed. The fibres are teased out in water or in glycerin tinged with picric acid, and then mounted in glycerin-jelly. If the nuclei are to be stained, the Koch tubercle stain diluted 4–5 times answers well. The preparations are then mounted in balsam.

Disintegration of Woody Tissues.‡—Prof. G. L. Goodale recommends the following method of disintegrating woody tissues for microscopic observation. The tissue is soaked for a sufficient length of time in a ten per cent. solution of potassium bichromate, then quickly freed from the excess of the salt, by once rinsing in pure water, and immediately acted on by concentrated sulphuric acid. After the acid has acted for a short time, the tissue is to be placed in a large quantity of water, when it will be found to have undergone more or less complete disinte-

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 461–70.
† Proc. Amer. Soc. Micr., 1889, pp. 34–45.
‡ Amer. Journ. Sci., xxxix. (1890) p. 79.

gration, each structural element being separated from its neighbours, with little or no corrosion of the wall.

Cleaning Diatoms.*—Mr. Edward S. Nott recommends that—

(1) The material be completely disintegrated by continued boiling in a solution of sal soda.

(2) The disintegrated material should be sifted in a sieve made of bolt-cloth, removing all the fine earths and broken forms.

(3) The remainder may have the greater part of the sand removed from it by revolving it in an evaporating dish with water.

(4) The material, now mostly diatoms, should be boiled in acids: first, in muriatic, then wash; second, in nitric, then wash, and sometimes boil also in sulphuric acid.

(5) After washing all traces of acid away, boil once more in a solution of sal soda, wash, and sift in a fine sieve of bolt-cloth.

The object is to remove all the debris and waste material before using the acids, as the result will be better and the expenditure of time and labour less. The stock should be kept in alcohol, and in mounting, the best distilled water should be used.

(4) Staining and Injecting.

Methylen-blue Staining for Nerve-endings.†—The examination of nerve-endings by staining with methylen-blue, a method invented by Ehrlich, has received, since its introduction, considerable attention at the hands of physiologists, owing to the comparative simplicity of the procedure, and the satisfactoriness of the results—results quite equal to those obtained by the silver nitrate and gold methods. The method as recommended by Prof. S. Mayer, consists of two distinct parts, the first of these being the treatment with the blue pigment, the second that of its fixation by means of picrate of ammonia. The methylen-blue solution is made by dissolving 1 gram of the pigment in 300–400 ccm. of a half per cent. salt solution. The picro-glycerin solution is composed of a cold saturated solution of picrate of ammonia, diluted with an equal volume of pure glycerin.

The animals are injected through a blood-vessel with the blue solution, or pieces of fresh tissue are soaked in the solution, or the animal may be immersed alive in the fluid without danger to life.

Small pieces of the object are then immersed in the picro-glycerin and are at once ready for examination. If found suitable for a permanent preparation the cover-glass can be fixed down with a mass composed of equal parts of wax and resin.

If found desirable the injected or impregnated preparations may be kept for some time in the picro-glycerin.

The effect of the second reagent is to alter the colour of the stained parts, all shades of red, brown, black being seen in the axis-cylinders and the non-medullated terminal nerve-expansions. This disadvantage is compensated by the stain being fixed and the preparation cleared up at the same time, advantages not counteracted by any considerable changes in the tissues.

* Proc. Amer. Soc. Microscopists, xi. p. 149. Amer. Mon. Micr. Journ., xi. (1890) p. 31.

† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 422–38.

The simplicity and rapidity of the method is seen when pieces of tissue are to be examined. Small pieces as fresh as possible are placed for about ten minutes in the methylen-blue solution, they are then well washed in a half per cent. salt solution and then examined at once in the picro-glycerin, the time required for all the manipulation being about 30 minutes. The results as to the positive and negative pictures attained by this procedure are equivalent to those produced by the action of silver nitrate on fresh tissues. Hence this method has all the advantages without any of the disadvantages of the silver method.

Technique of Golgi's Staining Method.*—The many recent modifications of Golgi's method of staining nervous tissue have tended, says Dr. E. Sehrwald, either towards improving the excellence of the picture or towards rendering the preparation permanent. But in effect these modifications practically destroy the picture, the finer details, visible enough in the silver solution, being lost during the manipulations required by the various modifications.

The author proposes a method which leaves intact all the details of the original silver chromate deposit and allows the preparation to be soaked in warm paraffin, so that sections of any required thinness may be prepared. This method simply consists in saturating all the reagents employed in Golgi's method with bichromate of silver. The only precaution required is that the reagents should be saturated with the salt at a high temperature.

In this discursive disquisition no details are given, the author, after minutely describing a long series of failures, contenting himself with a piece of general advice and stating that if this method be adopted preparations will be obtained which, if they have any fault, are too full of detail.

Method for Restaining old Preparations.†—Mr. J. W. Gatehouse gives the following method by which it is possible to stain objects that after mounting in balsam have become so transparent as to be scarcely visible. Take filtered oil of turpentine and saturate it with picric acid, adding the acid gradually till a fine yellow colour has been obtained, and scales of the acid remain undissolved. To this solution add carefully crystals of resublimed iodine, taking care to add only a few at a time, as otherwise the chemical action set up may possibly produce sufficient heat to ignite the turpentine and cause even a slight explosion. With all due care even, a series of small decrepitations may be noticed as the iodine dissolves. Sufficient iodine should be added to change the colour of the solution from a light yellow to a distinct brown tint. Then place the slide in a dish containing turpentine, to which some of the stain has been added, and allow it to remain there until the balsam is softened and the stain has penetrated and done its work, when the turpentine can be replaced by more balsam. In this way the author has restained slides of embryonic tissues which had been mounted several years and which had become almost invisible except in special lights. After two days' soaking the whole of the structures were brought out splendidly, every detail being perfectly clear.

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 443–56.
† Journ. Microscopy and Nat. Sci., iii. (1890) pp. 113–4.

Staining Elastic Fibres and the Corneous Layer of Skin.*—Herr A. Köppen recommends the following method for staining elastic fibres and the corneous layer. The sections, freed from all foreign constituents, are to remain for 24 hours or longer in absolute alcohol; they are then placed in the following staining fluid:—Saturated alcoholic solution of crystal violet, 5; acid. carbol., 5; aq. destil., 100. In this solution, freshly made, the sections remain for 15–24 hours. They are then placed in iodine solution for two minutes (I, 1; KI, 2; H_2O, 300), after this for five minutes in a 10 per cent. aqueous solution of common salt. They are then waved about for 15 seconds in 1 per cent. hydrochloric acid. Next they are decolorized in absolute alcohol. When sufficiently decolorized they are immersed first in turpentine and then in xylol, after which the sections are mounted in xylol balsam.

Prevention of Surface Deposits in Golgi's Chrôm-silver Method.†—Pieces of nervous tissues which are treated by Golgi's method are frequently rendered useless, owing to the thick deposit which altogether prevents the details of the preparation from being examined. This inconvenience, says Dr. E. Sehrwald, may be avoided by enveloping the pieces in a substance which, while it penetrates into the cavities and adheres closely to the surface, yet allows the silver salt to permeate without hindrance. Such a substance is gelatin in 10 per cent. aqueous solution. This, when cold, forms a firm but plastic mass, and melts at a temperature below that of the body.

It is best manipulated by pouring it over the object placed in a box made by winding a strip of paper round a piece of cork. When cold the box may be immersed in the silver solution. A piece about a centimetre square is quite saturated in 24 hours in the cold.

Although fresh pieces may be imbedded in the gelatin before being fixed in Müller's fluid, it is much better to envelope with gelatin after the Müller.

When the silver reaction is complete the gelatin must be removed, at any rate if the object is to be imbedded in paraffin. This is done with warm water to which chrom-silver salt, as explained above (see technique of Golgi's method, p. 409), has been added to excess. The solubility of the gelatin is but little affected by the action of the silver salt or by light.

Staining Paraffin Sections.‡—Those who have used the paraffin imbedding method for serial sections have, doubtless, wished for some simplification of the process of staining. This may be done, according to Dr. Kükenthal, by dissolving the colouring matter in absolute alcohol and dropping the solution into turpentine until the desired depth of colour is secured. Sections fixed to the slide with the collodion are kept in the oven until the clove oil has completely evaporated, the paraffin dissolved in turpentine as usual, and the slide brought into the dye. The staining is quickly effected. Over-staining may be corrected by placing the slide for a short time in a mixture of acid-free absolute alcohol and turpentine (equal parts). Turbidity of the colouring fluid may be corrected by adding a drop or two of alcohol; Meyer's carmine,

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 473–5. † T. c., pp. 457–61.
‡ Amer. Mon. Micr. Journ., xi. (1890) p. 11.

methyl-green, methyl-blue, gentian-violet, safranin, Bismarck-brown, eosin, fuchsin, tropeolin, and malachite-green may be used in the above ways.

MAGALHAES, P. S. DE.—**Estudo geral das colorações em histologia.** (Use of staining-methods in histology.) Rio de Janeiro, 1889, 8vo, 89 pp.

FEIST, B.—**Ueber die vitale Methylenblaufärbung markhaltiger Nervenstämme.** (On methylen-blue staining of living medullated nerve-fibres.) Strassburg, 1889, 8vo.

KRYSINSKY, S.—**Beiträge zur histologischen Technik.** 5. Kupfercarmin. 6. Lithiumcarmin und Lithiumpikrincarmin. (Contributions to histological technique. 5. Copper-carmine. 6. Lithium-carmine and lithium-picrocarmine.) *Virchow's Arch.*, CXVII. (1889) pp. 204–6.

MARTINOTTI, G.—**Alcuni miglioramenti nella tecnica della reazione al nitrato d'argento nei centri nervosi.** (Some improvements in the technique of the silver nitrate reaction on the nervous centres.) *Atti del* 12. *Congr. della Assoc. Med. Ital.*, I., p. 179.

MONTI, —.—**Una nuova reazione degli elementi del sistema nervoso centrale.** (A new reaction of the elements of the central nervous system.) *Atti della R. Accad. dei Lincei—Rendic.*, V. (1889) p. 705.

WEIGERT, C.—**Neue Neurogliafärbung.** (New neuroglia-staining.) *Münchener Med. Wochenschr.*, XXXVI. (1889) No. 29.

(5) Mounting, including Slides, Preservative Fluids, &c.

Mounting in Glycerin Jelly.*—Glycerin jelly, says Mr. J. D. King, answers more purposes as a mounting medium than any other, but it is dreaded by many on account of the difficulty of getting rid of air-bubbles, a difficulty which may be avoided by the following method. Heat the jelly in a water-bath till the water boils, then, always working in a warm room, mount with it as you would with glycerin except dipping the cover in fluid, being careful to remove any stray air-bubbles under the dissecting glass before putting on the cover, for even very small ones cannot be depended on to disappear of their own accord.

Small or delicate objects can be arranged and kept in place by first covering the bottom of the cell with glycerin jelly and placing the objects in it, being careful to cover them well, and leaving them to harden. When hardened, apply additional jelly and put on the cover. After standing overnight in a cool place, if the jelly be of good quality it may be cleaned off under water with a small paint-brush and finished off with cement. It is the better way to use cells for glycerin jelly mounts, though it is not necessary to fill the surface or apply the cement before putting on the cover-glass, or even in all cases to have them as deep as the object is thick. A cell prevents the cover-glass from touching the slide at any point, and thus creating a liability of forming a vacuum by shrinkage, and it makes better work every way.

New Mounting Medium.†—Mr. H. Shimer has devised the following mounting medium, the use of which gives every satisfaction. It is a mixture of equal parts of glycerin jelly, Farrant's solution, and glycerin. The glycerin jelly is made as follows:—Gelatin, 30 parts; water, 70 parts; glycerin, 100 parts; carbolic acid, 2 parts.

Of this glycerin jelly, liquefied by the heat of a water-bath, pour 1 fluid oz. into a 4-oz. glass-stoppered bottle, add an equal volume of the Farrant's medium and of glycerin. A little gentle agitating in

* Microscope, ix. (1889) p. 138. † T. c., pp. 143–5.

the water-bath will soon insure a complete mixing. Into this bottle drop a small lump of camphor.

This medium needs a little warming (about 110° Fahr.) to make it fluid for use.

Preserving Animals.*—Dr. C. J. Cori, after trying various fixatives as reagents for rapidly narcotizing small invertebrate animals, such as hot sublimate, chloral hydrate, ethyl-alcohol, certain alkaloids, such as strychnia and cocain, found that ordinary wood-spirit or methyl-alcohol, since it has little action on albumen and possesses sufficiently satisfactory narcotic properties, gave the best results. The formula for the solution is:—Methyl-alcohol 96 per cent, 10 ccm.; water, 90 ccm.; sodium chloride, 0·6 grm. The addition of the salt prevents the too great maceration of the tissues.

For preserving and hardening the author found that chrom-osmium-acetic acid in the following proportions gave excellent results:—chromic acid 1 per cent., 25 vols.; acetic acid 2 per cent., 5 vols.; osmic acid 1 per cent., 1 vol.; water, 69 vols. The specimens are said not to become blackened, and stain quite well.

If objects contain lime salts, these neutralize the acids, an inconvenience which can be obviated by using large quantities of the solution and frequent renewals of the fluid. In the fluid the animals remain, according to size, from 2-48 hours; they are then washed in running water for 6–72 hours, then placed in 50 per cent. spirit, and finally in 70 per cent.

The osmic acid is dissolved in distilled water to which so much permanganate of potash has been added as gives it a faint rose colour. A little of the salt should be added to the solution from time to time, or when the colour is beginning to fade.

The osmic solution is best kept in yellow or black glass bottles with two grooves in the stopper, a device which allows large drops to be obtained without removal of the stopper.

Agar as a Fixative for Microscopical Sections.†—M. A. Gravis recommends agar as a medium for fixing sections to the slide. According to the author it possesses several conspicuous advantages. It is quite liquid at the ordinary temperature; the sections can be arranged on the slide with great ease. Air-bubbles never appear beneath the section. Vegetable cells, which often become distorted when imbedded in paraffin, resume their shape and original dimensions. When well dried this fixative is insoluble in all reagents, except in distilled water. The specimens may be mounted in either balsam or glycerin.

The fixative is prepared by soaking half a gram of agar in distilled water for some hours. It is then heated gently until it boils. It is then boiled for about 15 minutes so that the agar may be completely dissolved. When cold it is filtered through a fine cloth and preserved in stoppered bottles.

In order to make the fixative stick properly, the slides must be perfectly clean. It is best to boil the slides in water acidulated with hydrochloric acid, and then, having rinsed them in distilled water, dry them on a clean cloth. The fixative is put on the slide with a brush.

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 437–42.
† Journ. de Microgr., xiv. (1890) pp. 83–5.

Upon this layer the sections are arranged. Directly this is done the slide is gently heated over a Bunsen's burner in order to soften, but not to melt, the paraffin imbedding. Any excess of fixative may now be removed by merely draining it off. The fixative is now to be thoroughly dried, and as this requires several hours, the slides should be covered over with a bell-jar and left till next day. The paraffin is then dissolved out either with warm turpentine or with chloroform, and then the solvent extracted by running some strong spirit over the slide. If the preparations have been stained *en masse* the slide is then dehydrated in alcohol, cleared up with oil of cloves, and mounted in balsam. If the sections require to be stained, the slide is merely placed in the staining solution, and when withdrawn, rinsed with spirit, after which it is mounted in balsam. As indicated above, almost any reagent may be used, provided it be not purely aqueous.

Use of Cajeput Oil for dissolving Canada Balsam.* — Prof. O. Beccari recommends the use of cajeput oil, obtained from *Melaleuca Leucodendron*, instead of oil of cloves, for dissolving Canada balsam. It has the advantage of being soluble in dilute alcohol, and the object can therefore be transferred directly from the dilute alcohol to the oil, which is not the case with oil of cloves. In addition, objects placed in cajeput oil and alcohol take up methyl-green and retain it in Canada balsam.

New Method of finishing Balsam Mounts.†—Mr. F. N. Pease remarks:—" It is only a question of time, when balsam mounts thoroughly hardened and unprotected from atmospheric influence will be ruined, on account of the cover-glass becoming detached, especially during rough handling. Discoloration of the mounting medium often occurs previous to the more serious result above mentioned, proceeding from the margin inward. On the other hand, preparations in which the balsam, storax, or other resinous media are used, are often injured by the running in of the cement used for finishing the slide, when sufficient care is not taken.

A method has been adopted, which effectively obviates these objections, and at the same time renders it possible to mount and finish a slide at once, without the delay due to allowing successive coats of cement to dry before others are applied. The mounts need not be thoroughly hardened before finishing, provided the nature of the preparation does not require it.

The method used is as follows:—The object is mounted on the slide, applying the cover-glass in the ordinary manner, using either balsam, hardened balsam, balsam and benzol, storax, or dammar. The slide is then heated to drive off the solvent, or more volatile constituents, either gently in the water-bath or at a higher heat, even boiling carefully over a spirit-lamp when the nature of the object will permit.

When cold, the superfluous mounting medium, when present, is carefully removed, then a narrow ring of paraffin wax is applied in the following manner:—hard white paraffin wax (such as is used for imbedding) is heated in a suitable capsule until it is melted and quite limpid. With the aid of a very small camel's hair pencil, the melted paraffin is applied at the edge of the cover-glass, covering the exposed mounting medium and instantly solidifying. With round cover-glasses and a turntable, very neat narrow rings of paraffin wax can be readily and

* Malpighia, iii. (1890) p. 410.

† Micr. Bulletin and Sci. News, vii. (1890) pp. 1–2.

rapidly applied. Whenever they are not satisfactorily symmetrical, a penknife may be used to bring them to the desired shape.

It is now necessary to apply a finishing cement. For this purpose Bell's cement has been found excellent, when modified as described below. The cement ring is finished at one application, enough being applied to produce a well-rounded ring. In a few hours the slide is ready for the cabinet. Bell's cement has been found at times to work unsatisfactorily, not flowing freely from the brush, and forming large bubbles in the ring, particularly in a warm room. The addition of a very little chloroform to the cement, and thorough mixing, produces a material that works smoothly, and dries with a satisfactory finish."

How to mount Objects in Motion for Examination by Polarized Light.*—Mr. George H. Curtis remarks :—" None of the manuals I have consulted give directions for preparing slides of objects in motion for polariscope. Rubber cells are best and they should be about 1/16 in. deep and preferably for a 3/4 cover. The medium I use is Canada balsam thinned with a not quite equal bulk of spirits turpentine. Stir well together, and when dissolved filter through cotton. Cement the cells to slide with something not acted on by turpentine, say shellac, or sealing-wax in alcohol. Le Page's liquid glue I think would answer, but I have not tried it. The fragments may be quartz, agate, sand, or anything not soluble in turpentine which polarizes well. One of the best is transparent gypsum or sulphate of lime. It is unnecessary to cement the cover on; set aside for a couple of days and the balsam will get dry enough to hold it. Should you wish to ring them with Brunswick black, size first with a coat or two of liquid glue made thin enough to flow, or the black will probably run in and spoil the slide."

Glycero-gum as a Mounting Medium.—Mr. C. C. Faris † finds a solution of gum arabic in glycerin preferable to Canada balsam or glycerin alone, as it is more transparent than balsam, with none of the objectionable features of glycerin. An object can be as well mounted in it without a cell as it can be mounted in balsam with a cell. The solution is made as follows :—Selected gum arabic, 2 oz.; glycerin and distilled water, of each $1\frac{1}{2}$ oz.; thymol, 1 gr. Mix the glycerin and water, and dissolve the gum arabic in it by heating on a water-bath. After the solution has been effected add the thymol, and filter through absorbent cotton by the aid of a hot-water funnel. To have the solution perfectly clear the most transparent pieces of selected gum should be chosen. The solution will then be transparent and brilliant, and be found a successful medium for starches and pollen. It has shown no signs of deterioration after four months.

Cleaning the Hands after working with Dammar Cements.‡—A writer in the 'National Druggist' says :—" As everybody knows who has worked at mounting, it is no easy matter to get the gummy and resinous material off the hands. Ordinary soap is of no avail, benzin is but little if any better, and aside from its costliness, benzol burns and dries the skin. I have used with a good deal of satisfaction a liquid soap made as follows :—Castile soap, shaved fine, 15 parts; alcohol 95 per cent.,

* Micr. Bulletin and Sci. News, vii. (1890).
† Western Druggist; Microscope, x. (1890) pp. 59-60.
‡ The Microscope, x. (1890) pp. 25-6.

10 parts; benzol, ordinary, 10 parts; ammonia water, 5 parts; glycerin, 5 parts. Dissolve the soap in the alcohol, add the ammonia water and benzol, and, after thorough agitation, the glycerin. After wetting the hands in plain water, the soap is smeared on with a bit of sponge over the patches of gum or cement, and well rubbed in. After washing and rinsing the hands, partly dry them on the towel, and finish by rubbing them over with a few drops of glycerin. The hands will not crack or chap in the coldest weather if the last precaution be taken. The soap will remain liquid during the summer, but solidifies in cold weather. It is, however, easily liquefied at all times."

(6) Miscellaneous.

'The Microtomist's Vade-Mecum.'*—Mr. A. B. Lee's work, the first edition of which appeared in 1885, has been so fundamentally revised and rewritten to such an extent that it almost seems like a new work. While a great number of processes have been omitted or only briefly mentioned, other subjects, such as fixation and fixing agents, have received more attention. The methods of killing now occupy a whole chapter, and other chapters, such as those devoted to staining with coal-tar colours, on imbedding processes, the methods of cytology, and on the central nervous system, have been re-written and brought up to date.

The present edition is more suited to the wants of the zoologist than to those of the pathologist.

Demonstration of Bacteria in Tissues.†—Dr. V. D. Harris has translated and edited Prof. Kühne's small work, which deals with the question of how to stain bacteria in animal tissues, and the answer thereto is somewhat affected by the author's peculiar but not unpractical views.

In addition to running through the technique of preparing, staining, and mounting specimens, it gives a few very useful formulæ and some useful pieces of advice.

The translation, which is decidedly Germanesque in style, also bears evidence of want of revision. For example, Mastzellen are usually translated plasma-cells, not fat-cells (p. 10). The 50 per cent. carbolic acid solution (p. 38, No. 1) does not agree with the 5 per cent. mentioned on p. 14. On the whole, we think that if the work were rewritten it might possibly be useful to some student unacquainted with the German tongue.

RAWITZ, B.—**Leitfaden für histologische Untersuchungen.** (Introduction to Histology.) Jena, 1889, 8vo.

REMY, CH.—**Manuel des travaux pratiques d'histologie, des éléments des tissues, des systêmes des organes.** (Manual of Practical Histology.) Paris, 1889, 8vo, 399 pp.

TYAS, W. A.—**Methods of Hardening, Imbedding, Cutting, and Staining animal** sections, and methods of mounting the same. *Trans. Manchester Micr. Soc.*, 1888, p. 83.

ZUNE, A.—**Traité de microscopie médicale et pharmaceutique.** (Treatise on Medical and Pharmaceutical Microscopy.) Bruxelles (H. Lamertin), Paris (J. B. Baillière et fils), 1889, 1 vol. sm. 8vo, 130 pp. and 41 figs.

* 2nd ed., London (Churchill), 1890.

† 'Guide to the Demonstration of Bacteria' (Kühne), translated by V. D. Harris, M.D., London, 1890, 52 pp. and 7 figs.

PROCEEDINGS OF THE SOCIETY.

Meeting of 16th April, 1890, at 20, Hanover Square, W., the President (Dr. C. T. Hudson, F.R.S.), in the Chair.

The Minutes of the meeting of 19th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Lee, A. B., The Microtomist's Vade-mecum. 2nd edition. ix. and 413 pp. (8vo, London, 1890)	*The Author.*
Spiral ruling on glass	*Mr. P. Braham.*
Photomicrographs of *Eupodiscus Rogersii*, *Isthmia nervosa*, *Navicula aspera*, and *N. Durrandii*	*Mr. Thomas Comber.*

Mr. J. Mayall, jun., called attention (1) to the new edition of the 'Microtomist's Vade-mecum,' by Mr. A. B. Lee; (2) to a spiral ruling on glass, sent by Mr. Philip Braham, of Bath, which was curious as having been produced in an ordinary lathe, the diamond point being adjusted on the slide-rest; (3) to a series of four photomicrographs of diatoms, sent by Mr. Thomas Comber, which would be found on examination to be of special excellence. The magnifying power was about 1000 diameters, and Mr. Comber evidently possessed first-rate appliances, and used them with much skill. Mr. Mayall thought these photomicrographs of particular interest from the fact that they were produced with sunlight, by which the maximum resolving power of the objective was obtained. He understood also that Mr. Comber employed monochromatic illumination. It was matter of regret that so few English microscopists used sunlight in their photomicrographic work. The climate was somewhat unfavourable; but yet there were occasional hours of sunshine that ought to be usefully employed in that direction. Artificial light was probably more easily manipulated; but still there remained the fact, long ago demonstrated by the late Dr. J. J. Woodward, of Washington, that sunlight gave the most perfect results.

Mr. E. M. Nelson said Mr. Comber had communicated with him on several occasions with regard to his apparatus and the methods employed by him in producing these photographs. His solar apparatus was of the most perfect description, at the same time it was simple, and his results showed a high advance upon anything of the kind previously done.

Mr. Mayall referred to an improved form of fine-adjustment constructed and exhibited by Messrs. Powell and Lealand, for the production of which he was himself chiefly responsible.

Dr. Dallinger said he had not yet had an opportunity of examining this new fine-adjustment; but he was quite satisfied that the more

delicate the workmanship that could be expended upon this portion of the instrument, the greater would be the advantage gained. He was satisfied that the adoption of these agate bearings would give a continuity and precision of movement which under such circumstances would be of immense advantage.

Mr. Goodwin exhibited a form of eye-piece for the Microscope, which, though not entirely new, he thought might be of interest to some of the Fellows of the Society. It had been designed by himself, acting upon the exigencies of the moment, by arranging the lenses so as to give a large field with considerable magnifying power. It would be seen from the drawing (made on the board) that it was the Huyghenian eye-piece modified by the introduction of a second plano-convex eye-lens, the convex surfaces of the two eye-lenses facing: the result was a field which was both large and flat, similar to that of a Kellner eye-piece but somewhat flatter. Some persons may find it troublesome to use on account of the angle of vision being too large to suit their eyes; this was a matter of personal equation, and was capable of being met by a slight modification in the construction. Since he had first exhibited this eye-piece he had found that Steinheil made one identical with it about twenty years ago; this fact was, however, unknown to him at the time his was designed. He had found it necessary to modify it somewhat since it was originally made, for although it worked well with his own objectives, it gave too much colour with those of other makers. To meet this difficulty the two eye-lenses had been fitted to slide in the tube, so that the distance between them and the field-lens could be altered as required, and this not only answered the purpose, but was of advantage in providing a means of adjustment which greatly assisted in the collar-correction. An alteration in the distance of 1/20 in. made a remarkable difference in the collar-correction.

Mr. A. W. Bennett said that a paper of great interest had been placed in his hands to bring before the meeting, "On the Freshwater Algæ of North Wales." It was, however, hardly a paper to be read on that occasion, because of its technical character and the long lists of species of which it largely consisted. He merely indicated the nature of its contents, as the paper itself would be printed in the Journal.

The President said that the thanks of the Society would no doubt be cordially given to Mr. West for his valuable paper, and to Mr. Bennett for the account which he had given them of its contents.

The President drew the attention of the meeting to Mr. Rousselet's tank, which was exhibited in the room (as described and figured in this Journal, p. 90). The trouble of catching a quick and lively rotifer in a tank, especially if nothing better were used than a watchmaker's eye-glass, was to him a matter of painful experience. In order to have both hands free, he had made for the purpose a pair of spectacles having one eye blank, and the other fitted with a high-power lens. For his purpose he should prefer to have a smaller tank, in order that he could use a higher power which would focus through, and then, if put against a

window, there would be no difficulty in following any desired rotifer. He should, perhaps, want one not more than a quarter of the size of that upon the table, though no doubt for the purpose originally intended it was all that could be desired.

Dr. Dallinger said he had one made for his own use of a size suitable for the × 10 magnifying power. He also found it to be an advantage to fit it upon a wooden mount provided with a winch, by means of which it could be raised or lowered as convenience required.

The President said that Mr. Rousselet had used with advantage a piece of black cloth or board on the other side of the tank, so as to obtain a black background, on which the rotifers were seen bright.

Prof. M. Hartog's paper "On the State in which Water exists in Live Protoplasm," was read by Prof. Bell, who explained that it was brought before the British Association at their last meeting, but had not been printed.

The thanks of the Society were given to the author.

Mr. E. M. Nelson said that Mr. Halford had been experimenting in the matter of mounting the spermatozoa of the Salmonidæ, obtained from the milts of spawning fish; but the results were not satisfactory. This year, however, he had mounted them in another way, and the result had been that details which had formerly been invisible with the highest powers, could now be seen with a 1 in. A paper descriptive of the method adopted was then read to the meeting, and specimens in illustration were exhibited by the lantern upon the screen. (See *ante*, p. 404.)

Mr. Mayall thought it would be well to mention that the gathering which was to have taken place this year at Antwerp in celebration of the 300th anniversary of the invention of the Microscope, had been unavoidably postponed until next year, in consequence of some difficulties which had been met with in getting ready the premises in which the meetings were to be held within the time at disposal.

Mr. E. M. Nelson then exhibited on the screen several slides showing under high powers (× 1350) the bordered pits of *Pinus sylvestris*, also radial structure in *Pinus* and *Tilia*. He also exhibited a small series of slides to show the qualities of a new apochromatic 1/4 in. objective, with fluorite lenses, and of ·95 N.A., one of a series of new apochromatic objectives recently produced by Messrs. Powell and Lealand. (Objects shown:—"Secondary" structure of *Isthmia enervis; P. angulatum*, with dry 1/4 in.; same diatom on dark ground, with 1 in.; same, with apochromatic oil-immersion 1/8 in.; fracture through "secondary" marking of *Triceratium favus;* "postage-stamp" fracture on *P. angulatum;* black dot on *P. angulatum*, with 1/4 in., × 600; same, with 1/2 in., showing white dot only.)

Mr. Bennett inquired, with regard to the bordered pits of the pine, whether Mr. Nelson was quite satisfied as to the existence of the membrane in the mature as well as the young structure, because it

seemed to him to be rather an important point, as affecting the generally received idea of the mode of nourishment in plants.

Mr. Nelson was unable to say what was the age of the specimens examined, as he did not prepare them himself. His impression was that there was an exceedingly delicate membrane covering a thicker membrane, which had a sieve-like perforation. The appearance struck him as being very much like that of a diatom just on the point of resolution.

The President reminded the Fellows of the Society that their next Conversazione would take place on Wednesday the 30th inst.

The following Instruments, Objects, &c., were exhibited:—

Mr. P. Braham:—Spiral ruling on glass.

Mr. T. Comber:—Photomicrographs of *Eupodiscus Rogersii*, *Isthmia nervosa*, *Navicula aspera*, and *N. Durrandii.*

Mr. Goodwin:—Eye-piece with large field.

Mr. Halford:—Spermatozoa of Salmonidæ.

Mr. E. M. Nelson:—*Asteromphalus Arachne*, viewed with Powell and Lealand's new apochromatic objective, 1/4 dry. Slides of bordered pits of *Pinus sylvestris* and radial structure of *Pinus* and *Tilia.*

Messrs. Powell and Lealand:—Mayall's Jewelled Fine-adjustment.

Mr. Rousselet:—Rotifers.

Mr. W. West:—Slides of Desmids from Capel Curig, North Wales, in illustration of his paper.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. James M. Allen, James B. Bessell, Frederick Justen, F.L.S., Herbert S. Martin, Henry W. Parritt, Helenus R. Robertson, Theodore Stanley, M.D., W. Le Conte Stevens, and Miss C. C. Crisp. Prof. F. Leydig, of Würzburg, was elected an Honorary Fellow.

Meeting of 21st May, 1890, at 20, Hanover Square, W., James Glaisher, Esq., F.R.S., Vice-President, in the Chair.

The Minutes of the meeting of 16th April last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Pringle, A., Practical Photomicrography by the latest methods. 183 and ix. pp., 6 pls. and 42 figs. (8vo, New York, 1890) ..	*Mr. A. Pringle.*
Marzoli's Achromatic Lens (1808)	*Messrs. Trainini Bros., of Brescia.*

Mr. J. Mayall, junr., referred to the donation by Mr. Andrew Pringle of a copy of his recently published work on 'Photomicrography.' He said

the volume embodied much practical information on the technical processes of photography; whilst the chapters devoted to the description of the various methods of adjusting the Microscope and accessory apparatus required in the production of photomicrographs bore everywhere traces of Mr. Nelson's co-operation, as frankly acknowledged by the author. It had struck him as somewhat strange that a work of this kind, addressed primarily to an American audience (for it was published by the Scovill and Adams Company, of New York) should contain so little reference to the employment of sunlight, the most powerful illumination at the disposal of the microscopist for photomicrographic work, and so generally available in America. The use of the electric light was also dealt with very cursorily, though he was under the impression that great facilities were offered in America for its employment. The oxy-hydrogen light was explained in considerable detail, and some excellent examples of photomicrographs produced with it were given.

Mr. Mayall also referred to the donation, by Messrs. Trainini Bros., opticians, of Brescia, of an early form of achromatic Microscope objective, constructed by the late Bernardino Marzoli, curator of the Physical Laboratory of the Lyceum of Brescia. He said the donation promised to be of historical interest; he would therefore explain the circumstances of its arrival, and the data which gave it special interest. In collecting notes on the early history of the application of achromatism to the Microscope, he had found a reference to Marzoli's achromatic objectives in Giovanni Santini's 'Teorica degli Stromenti Ottici,' published in Padua, 1828 (2 vols. 8vo). In vol. ii. p. 187, Santini mentioned Selligue's then recent achromatic objectives as described in the French journals, and stated that Marzoli, of Brescia, had long preceded Selligue in the production of such objectives. Such a statement by Santini seemed to him to merit special attention, and he determined to make inquiries at Brescia for any traces of Marzoli's objectives. By the courtesy of Mr. Frederick Justen, a newly-elected Fellow of the Society, a communication of the particulars was made to the President of the Athenæum of Brescia, who most kindly saw the Brothers Trainini, the grand-nephews of Marzoli, on the subject. These gentlemen replied, stating that Marzoli was an amateur optician; that he had taken much interest in the application of achromatism to Microscopes; that a paper of his on the subject had been summarized by the secretary of the Accademia di Scienze, of Brescia, and published in the *Commentarj* for the year 1808; that he had exhibited his achromatic objectives at Milan in 1811, for which he had been awarded a silver medal under the authority of the *Istituto Reale delle Scienze*, of Milan; that they possessed one of these objectives, which had been "religiously preserved," and they would send it to the Royal Microscopical Society if it were thought acceptable. He (Mr. Mayall) replied to Messrs. Trainini, assuring them that such a donation would be much appreciated by the Society. and requesting them to furnish the fullest information regarding Marzoli's actual work, and if possible send a copy of any official document that might exist to confirm the fact that he received a public recognition of his labours in connection with the production of achromatic objectives so early as 1811. Messrs. Trainini forwarded (1) the *Processo*

Verbale, or official record of the awards, containing the notification of Marzoli's exhibits, and of the silver medal decreed for them; (2) they sent the actual Diploma, dated August 20, 1811, signed by the Italian Minister of the Interior, in which the exhibits and award were duly set forth, and the congratulations of the Minister conveyed to Marzoli personally. Since then he had had access to the vol. of the *Commentarj della Accademia di Scienze*, of Brescia, for the year 1808, and was thus able to place before the Society what he thought must be regarded as satisfactory evidence establishing the fact of Marzoli's early connection with the application of achromatism to Microscope objectives. The volume he had just mentioned contained a plate drawn by Marzoli, in which his achromatic objectives were figured, and also the special apparatus he had devised for their construction. It was a point of interest to find that the objective received appeared to correspond almost exactly with the figures, and hence the probability of their being contemporaneous demanded no great stretch of imagination; at any rate, the figures spoke for themselves, and fixed the date 1808, whilst the Diploma anent the award of the Silver Medal fixed the date of 1811, so that Santini's claim on behalf of Marzoli's having preceded Selligue in the production of achromatic objectives, was abundantly confirmed. The date of Selligue's objective was fixed (1) by Charles Chevalier's "Notes Justificatives," published in Paris in 1835, in which he stated that he and his father made an achromatic Microscope for Selligue in 1823, which was exhibited at the Académie des Sciences on April 5, 1824; and (2) there was Fresnel's special report on that exhibit communicated to the Académie on August 30, 1824. It would be manifestly unfair to Selligue to ignore the fact that his capital improvement over every suggestion of his predecessors was the idea of so constructing the achromatic doublets that they could be used in combinations of three or four in superposition. Marzoli's objective was a cemented combination, and in the figure published in 1808, the plane side of the flint was downwards, as if presented to the object; but whether this was a mere accident in the drawing, or whether it was intended to be used, must be matter of conjecture. His (Mr. Mayall's) own conjecture was that it was intended to be employed as figured, for the drawing being made by Marzoli himself, it was hardly probable that he would have inverted the objective; still it was not certain that Marzoli preceded the Chevaliers' practical discovery of the improvement due to the presentation of the plane surface of the combination to the object to be viewed.

There were still many obscure points in the early history of the achromatic Microscope which could not be satisfactorily explained unless access were obtained to the achromatic objectives made by B. Martin (1759), N. Fuss (1774), Van Deyl (1807), Charles (1800–1810), Amici (1815), Fraunhofer (1816). The late Prof. Harting had met with an objective by Beeldsnyder, to which he assigned the date 1791, and, by the courtesy of Prof. Hubrecht, of the University of Utrecht, he (Mr. Mayall) had examined it with much interest; but the workmanship was not such as to give much promise for the future development of the achromatic system. Marzoli's objective, just received from Brescia, was of excellent workmanship, and might fairly be said to have demonstrated the importance of achromatism in those early days. The

authorities at Milan had shown conspicuous judgment in their recognition of Marzoli's skill by the award of a silver medal. He trusted the Society would give the lens most careful guardianship in their cabinet of apparatus, and that he should be empowered to express officially to Messrs. Trainini their high appreciation of the donation.

The Chairman said the Society were much indebted to their Secretary, Mr. Mayall, for his very interesting communication, and he had much pleasure in proposing, first, that the best thanks of the Society be given to their Secretary for his energy, tact, and perseverance in following up the subject, and for bringing it before them in the way he had done; and, secondly, that their best thanks be also given to the donors of the lens, and that the Secretary be requested to assure them of the high value in which it was held, and always would be held, by them as a Society.

Mr. Charters White inquired if it was known what was used for the purpose of cementing the lenses together, Canada balsam being at that time unknown?

Mr. Mayall thought it was not quite certain that Canada balsam was unknown then; but it was a fact that Clairaut, the eminent French mathematician of the last century, had proposed that lenses might be cemented together, believing that he had thus suggested an important improvement upon Dollond's uncemented achromatic telescope object-glasses.

Mr. Powell said that gum mastic was frequently used for the purpose; his firm many years ago used it constantly.

Mr. Mayall said it would be remembered that at the last meeting Mr. Goodwin brought forward an eye-piece for which some advantages were claimed. Almost immediately after that meeting he received a note from Mr. Philip Vallance, who, having seen a report of Mr. Goodwin's communication, wrote to say that he had in his possession two eye-pieces which were made for him on the same plan nearly forty years ago by Mr. Murrell. Mr. Mayall said, as a matter of fact, this form was very old indeed, dating from about 1667. Mention was made of one like it in the 'Philosophical Transactions,' constructed by Eustachio Divini shortly after the publication of Hooke's 'Micrographia,' 1665. In Birch's 'History of the Royal Society,' an extract from the Society's minutes showed that Christopher Cock, the optician who worked for Hooke, was requested to exhibit at the Society a large Microscope having such an eye-piece. Later on Grindl, of Aix-la-Chapelle, mentioned the same thing, and it had been also employed by others, with more or less modification, throughout the last century, and later. Then with regard to the other point of novelty claimed by Mr. Goodwin—the possibility of adjustment—it seemed that in those which Mr. Philip Vallance had made for him there was a screw provided which enabled the compound eye-lens to be adjusted, with reference to the field-lens, through a space of nearly 1/2 in.

Mr. E. M. Nelson read a paper on "Micrometers," in the course of which he described a new micrometer made for him by Messrs. Powell and Lealand. The subject was illustrated by a drawing upon the board,

and the micrometer, attached to a Microscope and lamp, was also handed round for inspection.

The Chairman thought that papers like the one just read were of great practical value, and that all would be grateful for the observations which had been made.

Mr. Thomas Comber's paper "On a Simple Form of Heliostat and its application to Photomicrography," was read by Mr. Mayall, who explained that having been much struck by the excellence of the results of Mr. Comber's work, shown at the last meeting, he had requested him to forward a description explaining the construction and application of his heliostat. Mr. Comber had not only given these explanations, but had sent the heliostat for inspection, together with photographs showing the installation of his photomicrographic apparatus. Apart from the question of the extreme simplicity of the heliostat, which was mainly due to limiting the reflection of the mirror to the polar direction, and deflecting the pencil in the horizontal direction in the axis of the Microscope by means of a fixed mirror, placed at half the angle of the latitude, above the heliostat mirror, Mr. Comber had rendered important service to photomicrography, by showing how the heliostat might be placed close to the Microscope, so that the error due to slight inaccuracy of the adjustment of the heliostat might escape the optical leverage which took place when the reflected beam was made to travel through a considerable space—which obtained with heliostats, as usually placed with reference to the Microscope. Mr. Comber's observations on the fallacy of employing monochromatic illumination for photomicrography would have to be most carefully considered by microscopists, for if they stood the test of experience—and Mr. Comber was evidently a careful observer—the process would be permanently simplified. Mr. Comber had certainly devised a very practical method of using sunlight; he wished he could give them any equally practical means of obtaining more of it.

Mr. E. M. Nelson said that with regard to Mr. Comber's paper, which he had listened to with great interest, there were one or two points upon which he would remark. He thought great credit must be given to Mr. Comber for the admirable way in which he had simplified the heliostat. However necessary a universal heliostat might be for other scientific purposes, the instrument exhibited furnished a practical demonstration that for photomicrography not only was it unnecessary, but the other and far simpler and less expensive non-universal was really the more efficient of the two. The universal heliostat gave a steady beam over a considerable range of directions, but the non-universal only in one. On that account the non-universal needed two mirrors; the slight loss of light thus occasioned was no real detriment, because, generally speaking, there was more light than was required. Then, with reference to monochromatic illumination, he would direct special attention to that passage where Mr. Comber stated that the plate itself made a time selection of the actinic ray. The importance of that sentence could not be over-estimated. Speaking for himself, he could only look back with regret at the amount of time wasted with prisms and absorption media, merely from the want of knowledge of

that fact. His was no isolated experience. With reference to the correction of achromatic lenses for photomicrography, he went some time ago through an exhaustive series of trials with an achromatic homogeneous-immersion objective, whose actinic focus was displaced from its visual, but which, nevertheless, yielded a very fine image at that visual focus. A number of biconvex correcting lenses, placed immediately behind the objective, were tried, and it was found that a suitable lens would bring back the actinic focus to the plane of the visual. When, however, the focus was brought back, the actinic image was quite unlike the visual, inasmuch as it had lost all sharpness. The image resembled that yielded by an objective quite out of adjustment. He had next tried monochromatic illumination, with no better results. One thing only remained to complete the experiments, and that was monochromatic sunlight. Not being in a position to carry out these experiments himself, Mr. Comber very kindly undertook them for him. The results he obtained with a very fine duplex-fronted water-immersion 1/12 of 1·22 N.A. entirely agreed with those formerly obtained. In his opinion, no ordinary *achromatic* lens could be corrected for photomicrography. He did not for a moment doubt that its actinic focus could be brought into coincidence with its visual; but if the lens yielded a crisp visual image its actinic image would be out of correction. He believed that no lens could be said to be corrected for photomicrography which was not *apochromatic* in the strict meaning of the word.

The Chairman said that this heliostat seemed to be rigidly for use in one latitude only. The subject was one of much interest and utility to those who were working at photomicrography, and their thanks were justly due to Mr. Comber for his communication.

The following Instruments, Objects, &c., were exhibited:—

Mr. T. Comber:—Heliostat in illustration of his paper.

Mr. J. Mayall, Jun.:—Marzoli's Achromatic Lens (1808).

Mr. E. M. Nelson:—New form of Micrometer Eye-piece.

Mr. Vallance:—Eye-piece with Compound Eye-lens giving extra large field.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs Philip Braham, F.C.S., William Forgan, Thomas H. Hall, and W. Scott Lang, M.D.

Fig. 2.

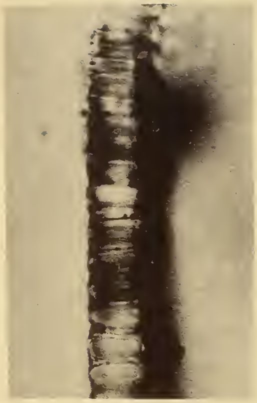


Fig. 3.

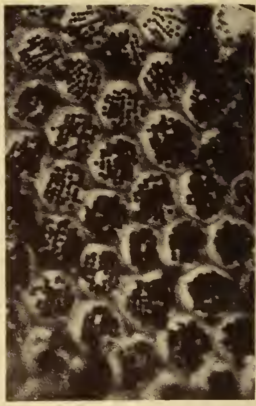


Fig. 7.

Fig. 9.

Fig. 1.

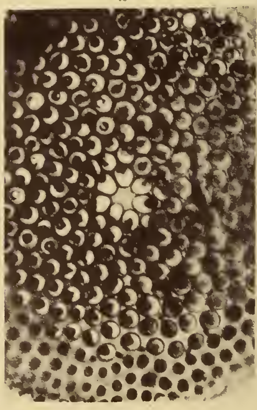


Fig. 8.

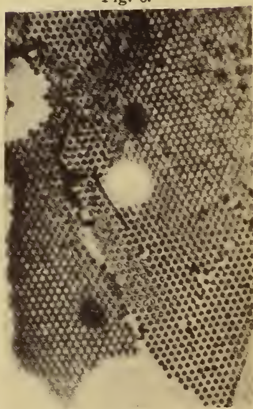


Fig. 5.

Fig. 4.

Fig. 6

C. Haughton Gill, Photo. J. Maes, Phototyp.

Diatoms charged with Mercurous Sulphide, &c.

By C. Haughton Gill.

Journal of the Royal Microscopical Society.

August 1890.

Transactions of the Society.

VI.—*On some Methods of preparing Diatoms so as to exhibit clearly the nature of their Markings.*

By C. Haughton Gill, F.C.S., F.R.M.S.

(*Read* 19*th March*, 1890.)

Plate VII.

In a note communicated to the Society's Journal for December last I drew attention to the fact that certain diatoms when treated as therein shortly described, became so "charged" as to clearly demonstrate that their markings ("striæ," "dots," &c.) were hollows or cavities of some kind, as they were capable of being filled with foreign matter.

Having been asked to give more detailed particulars of methods and results I beg permission to submit the following.

Diatoms may have their "lacunæ" filled or partly filled by either of the methods described below, of which the third is by far the best as a general one.

(1) *Prussian-blue Method.*—Applicable only to such diatoms as have very coarse markings. The cleaned and ignited diatoms are boiled and soaked for several hours in a strong solution of ferric chloride (perchloride of iron); then to the cooled liquid is added a saturated solution of potassium or sodium acetate, whereby the ferric

EXPLANATION OF PLATE VII.

Fig. 1.—Inner surface of a Coscinodisc "charged" with mercurous sulphide. Some of the cells broken away, × 825.

„ 2.—Edge view of fragment of a Coscinodisc, showing the honeycomb structure of the valve, × 825.

„ 3.—Cell-cappings of a *Triceratium.* The perforations (secondary markings) filled with mercurous sulphide, × 825.

„ 4.—*Pinnularia major* (?). Striæ wholly or partially "charged" with mercurous sulphide, × 825.

„ 5.—*Stauroneis phœnicenteron* with lacunæ partially charged with mercurous sulphide, × 1750.

„ 6.—*Cocconema lanceolatum*, partially charged with mercurous sulphide, × 825.

„ 7.—*Epithemia turgida*, charged with mercurous sulphide, × 825.

„ 8.—*Pleurosigma angulatum*, charged with silver sulphide, × 1750.

„ 9.—*Surirella gemma* charged with silver sulphide, × 1750.

chloride becomes converted into the very dark red ferric acetate. The diatoms are now allowed to settle closely for two or three hours, and the excess of iron salt poured off as completely as possible. Next the test-tube with the moist diatoms is stood in a small vessel of boiling water till all the ferric acetate has passed into the basic state, as evidenced by its changing to an opaque buff colour. The diatoms, now "charged" with the insoluble basic ferric acetate, are shaken up with a few drops of water and acetic acid, and poured into not too great an excess of a solution of potassium ferrocyanide in acetic acid. After standing for some hours with occasional agitation, the excess of Prussian blue which has been formed among and around the diatoms can be removed (at any rate in great part), by repeatedly shaking up with fresh lots of distilled or rain water, as after elimination of the soluble salts this body assumes a form which settles very slowly indeed. Stirring the settled diatoms with a soft camel's-hair brush helps to remove the precipitate which may be clotted on their surface.

(2) *Platinum Method.*—Applicable to all diatoms, but apt to fail. To the cleaned and ignited diatoms contained in a small porcelain crucible add an alcoholic solution of sodio-platinic chloride, and evaporate with extreme slowness and without any approach to boiling. Finish the drying with the utmost care, to prevent the formation of bubbles of steam within the minute cavities, as this would result in ejection of the platinum salt and the consequent failure of the preparation. When *quite dry* raise the temperature very slowly till a low red heat is reached, and then throw a few crystals of oxalic acid into the crucible and immediately replace the cover. This completes the reduction of the platinum salt to metal and sodium chloride, and it now only remains to wash away the latter and as much of the unattached platinum as possible, and to select any required diatom from the residue.

(3) *Mercurous Sulphide Method.*—As stated above, this is the best method I have hitherto found for "charging" all diatoms except those having the finest markings. Take a cold saturated solution of mercur*ous* nitrate (*sub*-nitrate of mercury) and dilute it with its own bulk of water in a small test-tube. Add the diatoms and a drop of metallic mercury, and keep the whole standing corked up for as long a time as can be spared—days are better than hours, and weeks better than days. Shake the tube and withdraw the diatoms suspended in the liquid by help of a pipette, leaving behind any crystals of basic sub-nitrate of mercury which may have formed. Allow the diatoms to settle in a small test-tube, and draw off the supernatant liquid first by a pipette and then by a moistened thread or a very thin strip of filter paper till nothing but a slightly moist mass of diatoms remains. Now add several drops of a strong solution of ammonium sulphide which has been recently prepared, and which is practically free from dissolved sulphur (it should be almost colourless, not yellow), and shake. Fill up the tube with water, cork, and

allow the whole to stand for some hours. Wash and levigate as in the other methods. The mercurous sulphide thus formed is a black amorphous precipitate, which fills the "lacunæ" of the diatoms with an almost completely opaque stopping. Mercuric sulphide is apt to become red and crystalline; hence the necessity of the precautions to avoid the conversion of one into the other, which are detailed above. The only fault of this method is that the sulphide is somewhat apt to clot and become difficult to remove from the outside of the valves by washing. Perhaps this would be avoided by using weaker solutions than those I have worked with.

(4) *Silver Nitrate Method.*—A strong solution of silver nitrate (about 100 grains to the oz.) may be substituted for the mercurous nitrate, but on the whole does not serve so well except for those diatoms having the finest markings, e. g. *Pleurosigma angulatum.* The silver sulphide formed is brown and less opaque than the mercurous sulphide, but is not so apt to clot over the surface of the object.

By none of these methods will every diatom in a batch be equally well charged.

Diatoms treated by one or other of these methods exhibit very clearly that all "striæ," "dots," &c., are, as stated in the first paragraph, cavities of some kind, which, in default of a better name, might be called "lacunæ" or "pores."

Whether these lacunæ are complete perforations through the silicious test or mere pits or depressions on the inner or outer surface of the valve, or more or less flask-formed cavities communicating by one or more canals with the inner or outer surface, or with both, cannot at present be resolved with any degree of certainty in the case of those diatoms which have the finer markings. But in the case of some large Coscinodiscs it can be shown that the valve has a structure which may be described as cellular. Where the areolæ are widely separated from one another, a fragment of a charged valve viewed edgeways presents the appearance of a number of mammæform cells springing from the inner side of the outer face of the valve by their wider extremity, and terminating in a more or less conical perforated apex at the end facing inwards. Fig. 1 shows a valve of this description on the flat. All my edge specimens have spoilt themselves by rolling over.

Where the areolæ are very close together, so as to cause one another to assume the hexagonal form, the cells which constitute their prolongation partake of the same form, and their inner faces join together to form a perforated plate of considerable substance. The whole structure presents a close resemblance to a single layer of honeycomb cells with their cappings and bases complete but perforated. Fig. 2 exhibits an edge view of a fragment showing this structure.

The outer face or surface of these cells, very commonly if not universally, consists of a thin silicious membrane pierced with a

number of minute holes arranged in a symmetrical manner (constituting the so-called secondary markings), which differs in every species I have observed. Fig. 3 shows a portion of such a capping of one of them.

The cell-walls connecting the two surfaces are exceedingly thin and fragile, and are easily destroyed and lost sight of, while the two plates which they join are comparatively stout, and are often found separate and entire. The details of cell-form vary widely in different species.

In the case of the larger *Pinnulariæ*, e. g. *viridis* and *nobilis*, it can be easily seen that the striæ are pseudo-tubes contained in the walls of the valve, and which may be considered as formed by the lapping towards one another of the edges of a groove sculptured on the inner wall of the valve. I have observed indications of channels of communication between these pseudo-tubes and the outside of the valve, similar to those forming the secondary markings of the Coscinodiscs, but seek further confirmation. Fig. 4 shows a partly charged valve of *Pinnularia major* (?).

Of "dotted" diatoms, *Cocconema lanceolatum* (fig. 5), *Stauroneis phœnicenteron* (fig. 6), and the various *Pleurosigmæ* and *Naviculæ*, all that can be affirmed with certainty is that the dots are hollows. Further experiment is required to determine the point whether they have or have not the same cellular structure as the Coscinodiscs. Mr. Smith has shown that they have two skins or layers; is it not probable that these are connected in the same manner as those of the larger forms? Edge views of fragments of charged *Cocconema* and *Stauroneis* seem to show the black sulphide extending as a streak from one face to the other of the single valve, but in the case of such exceedingly minute structure, as is here in question, it is very easy to be misled by one's prepossessions, and it is therefore quite possible that on this point I have been deceived. What precise function these lacunæ or pores fulfil in the economy of the organism, is a question which I hope to study in the immediate future.

VII.—*On a Simple Form of Heliostat, and its Application to Photomicrography.*

By Thomas Comber, F.L.S.

(*Read* 21*st May*, 1890.)

Your Secretary has asked me to give your Society a detailed description of the apparatus I use for photomicrography, and of my method of working; but it appears to me that it will be simpler and shorter, and at the same time answer every purpose, if I merely explain those features in which my mode of working differs from that which I believe is generally adopted by others, and is probably sufficiently well known. The general nature of the arrangement will be apparent from the woodcuts.

The two main objects that I have endeavoured to attain have been, firstly, a means of sunlight illumination, easily applied, quickly adjusted, and simple in construction so as not to be liable to get out of order; and secondly, an arrangement which admits of convenient and comfortable eye-observation, for the purpose of arranging the object and adjusting cover-correction, before the camera is attached to the Microscope.

So far as my experience goes, for high magnification—other things being equal, both as regards objectives and manipulative skill—better results can be obtained by sunlight than by any other kind of illumination. The photomicrographs produced by Mr. Nelson and other of your members by oxyhydrogen light may be superior to what others have produced by sunlight; but this is due to their superior optical appliances and greater skill as microscopists, which more than compensates for what I cannot help regarding as inferior illumination. The same operator, using the same lenses, will, I am confident, produce better results by sunlight than by any artificial illumination.

The reasons sunlight has been so little used in this country are probably (1) the uncertainty of our climate; (2) the fact that many of our microscopists work chiefly in the evening; and (3) the complicated nature of the heliostats obtainable, which renders them very liable to get out of order, and so difficult to adjust that, when sunlight is available, much time is lost in setting up the apparatus; and, consequently, before everything is in working order, the sun may too often become clouded. The last objection is aggravated by the heliostat being usually placed a considerable distance from the Microscope, and sometimes even outside a window; and, as any error in the action of the heliostat is increased in proportion to the distance, it has been found almost impossible to keep the illuminating beam unchanged by the motion of the sun.

To avoid this difficulty, I place the heliostat inside the window,

and bring it quite close to the Microscope, so that it is within arm's length of the observer, and the sunbeam has so short a distance to pass before it reaches the substage condenser, that any slight error of the heliostat is of comparatively little consequence. The heliostat and all the accessories are fixed, once for all, on a wooden stand, so that they have not to be arranged each time they are used, but the stand has merely to be placed before the Microscope, and everything is in its proper relative position.

The heliostat itself is a brass time-piece A, fig. 47, to which is added an additional motion, causing the spindle, which need not be in the centre, to revolve once in twenty-four hours. It is mounted on a triangular brass plate, furnished with levelling screws, and is fixed at an angle to the horizon, corresponding to the latitude of the place in which it is to be used. When the point of the brass plate is directed due south, and the plate itself is levelled, by means of a spirit-level, in both directions, the clock is in the plane of the equator, and the spindle, at right angles to it, is parallel to the axis of the earth, and points to the North Pole of the heavens. The spindle is made slightly conical, and fitted to it, friction-tight, so as to be capable of easy rotation by the hand, is a small mirror B, with universal motion. The size of mine is two inches by one, which is ample. This mirror has to be set to reflect the light from the sun in the direction of the spindle, when the rotation of the spindle, corresponding exactly with that of the earth, only in the reverse direction, compensates for the apparent motion of the sun, and the reflected beam remains motionless. Where the reflected beam crosses the optic axis of the Microscope, there is placed a second fixed mirror C, inclined to the horizon at an angle equal to half the latitude, which reflects the beam in the axis of the Microscope. Between this fixed mirror and the condenser is placed an alum-cell D, to absorb the heat. In originally fixing the position of the mirrors, care has to be taken that the centre of the fixed mirror is truly axial with respect to the substage condenser and Microscope, and that, reflected in it when viewed through the Microscope, the spindle of the heliostat appears exactly end on, in the centre of the field. The heliostat will then be in its correct position, and the movable mirror can be placed upon it. All this may seem very complicated in the description; but once the position of the various pieces has been thus settled, all that has to be adjusted is the movable mirror, and its adjustment is no more difficult than that of the mirror which forms the ordinary adjunct of the Microscope. If the mirrors are of glass silvered at the back, the first gives a double reflection, which is again doubled by the second, and great loss of light is experienced. Glass silvered on the surface avoids this, but I found it tarnished quickly; so that I have had to adopt reflectors of speculum metal. These also are open to objection, for the light they reflect is distinctly reddish in tinge, and I believe there is considerable absorption of the rays of highest refrangibility.

The window at which I work faces about S.E., and has the sun from early morning until about two P.M., and, to ensure the apparatus

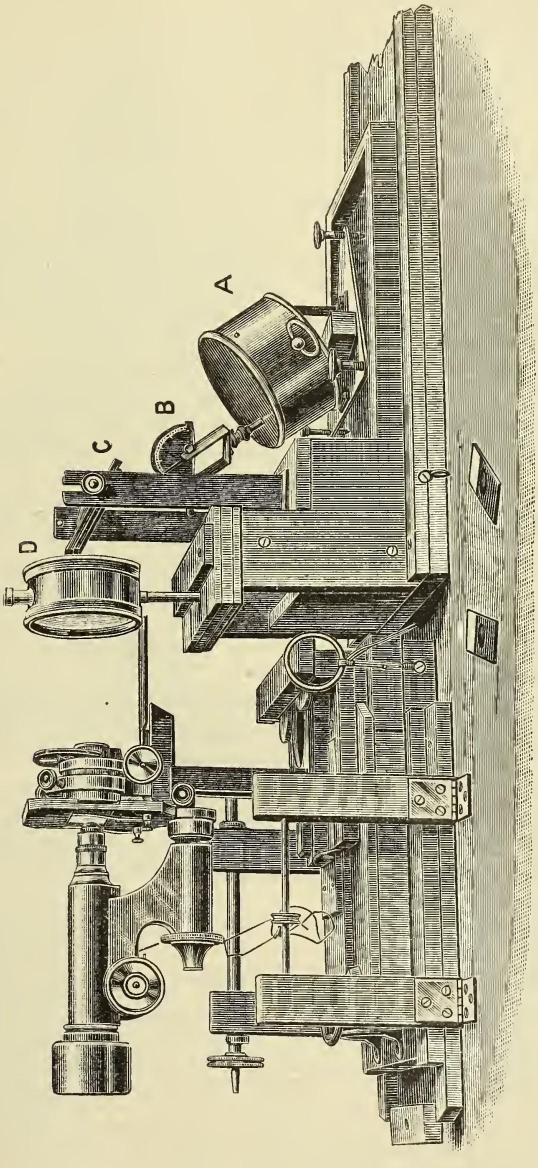


FIG. 47.

being placed due south, the end of the board upon which the heliostat stands is cut off at the angle corresponding to the glass of the

window, so that the table can be easily placed exactly in the required position.

The table itself (fig. 48) is heavy and solid, and stands upon three legs, so as to secure an equal bearing. It is at such a height that the horizontal Microscope-tube is at a convenient level for eye-observation, when the observer is seated, so that all the preliminary adjustments, as regards cover-correction, &c., can be comfortably made, and the illumination regulated, before the camera is attached. The base-board of the camera pivots on a steady tripod, and can, during this process of adjustment, be swung aside out of the way, but be brought round when required, and the anterior end of the base-board then fits to the edge of the Microscope table. The attachment of the camera to the Microscope is effected in the usual manner. For my own work, I find it most convenient to use a camera of fixed length, viz. one metre from eye-piece to sensitive plate; but a bellows body, capable of variable extension, can, of course, be substituted if desired. The focusing rod disconnects at the anterior end of the camera, sliding back off a square pin from the portion attached to the Microscope table. It works by means of a string, that passes round the milled head of the fine-adjustment (Fig. 49). The bar which carries the socket of the substage condenser has attached to it a small platform, upon which can be placed a screen of dark-blue glass, to subdue the glare for eye-observation, or a small cell containing ammonio-sulphate of copper or other solution, for producing monochromatic light.

So far, however, I cannot say that I have experienced any practical advantage from monochromatic light. It appears to me that when ordinary sunlight is used, the blue-violet rays are so prepotent in their actinic power that they do all, or nearly all, the work, and the other rays have not time to produce any material effect. The supposed advantages of monochromatic light are then practically attained without any special means, unless, indeed, some special method can be devised for working with rays of shorter wave-length than the blue-violet; and any suggestion for accomplishing this I shall be glad to receive, and to give it a trial.

The resolving power of our objectives depends not only upon their numerical aperture, but also upon the wave-length of the light used; and the high ultra-violet rays should therefore give a higher resolving power than the blue-violet; but I have not yet succeeded in making them operative in practice.

As regards general manipulation, the only special recommendations that I have to make are :—(1) That the cone of illumination should always be strictly axial. (2) That the image of the sun should be focused exactly in the plane of the object, so that it shows sharp and clear on the ground glass when the object is in focus. Clouds close to, or passing across the face of the sun, should be seen almost as if a landscape lens was being used. (3) That no unachromatized lens

should be introduced in any part of the system. I cannot, therefore, advise the use of a bull's-eye between the source of light and the sub-

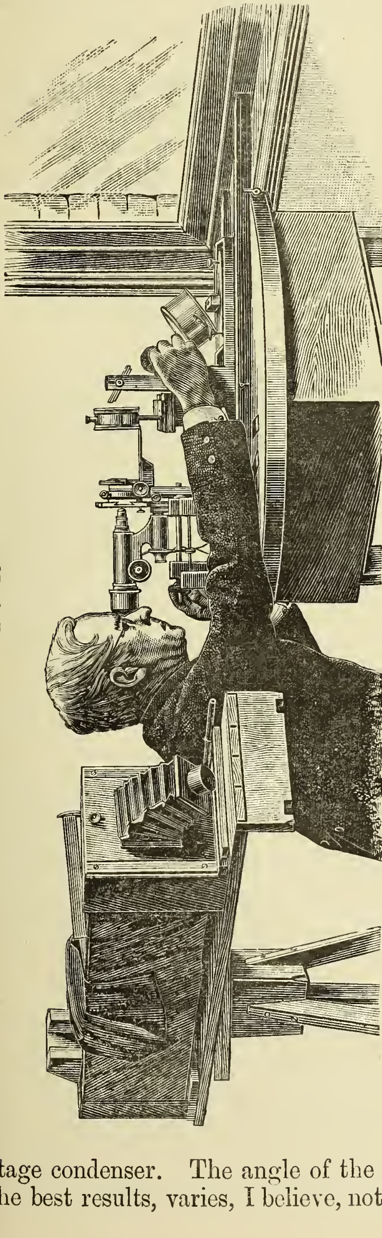


Fig. 48.

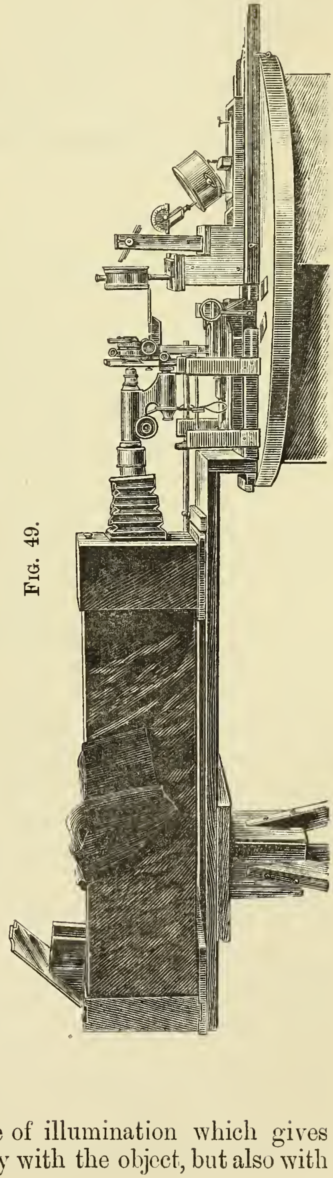


Fig. 49.

stage condenser. The angle of the cone of illumination which gives the best results, varies, I believe, not only with the object, but also with

the individual objective used. Too narrow a cone is apt to cause diffraction fringes, too wide a cone produces haze. I have not had much experience in photographing test diatoms, but so far as it goes, I find that my own 2 mm. Zeiss Apochromatic, 1·4 N.A., gives its best definition of such objects when about two-thirds of its back lens is filled by the dioptric beam.

I trust this description of my apparatus will enable others who may be desirous of using sunlight illumination to adopt it, and, I hope, improve upon it. I shall be pleased to answer any inquiries as to any point that may not have been made sufficiently clear.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Inheritance of Acquired Characters.‡—Dr. J. F. van Bemmelen has written a detailed history of opinions and theories in regard to heredity, with special reference to the problem of the transmissibility of individually acquired characters. After a brief sketch of Weismann's position, he reviews with great completeness the relevant literature. Beginning with Hippocrates and Aristotle, he passes to Buffon and de Maillet, Robinet, and Bonnet, and thence to Lamarck and the "Transformists." The opinions of modern naturalists are classified according to the predominance of anthropological, physiological, and pathological considerations. Scholarly as the record is, we find some serious omissions, as, for instance, of Brooks and Galton.

Studies in Mammalian Embryology—The Placenta.§—Prof. A. A. W. Hubrecht describes the placenta of *Erinaceus europæus*, and discusses the general history of placentation.

I. *Development of Yolk-sac and Allantois.*—The youngest blastocyst observed had the form of an oblong sac, and measured 1/10 mm. Its outer wall inclosed a few aggregated cells—the future hypoblast. The wall soon becomes more than single-layered, and exhibits an internal projection at the "anti-mesometrical" pole. Rapid growth thins out the wall of the blastocyst into a unicellular layer, with lacunar spaces containing maternal blood, and with numerous villiform processes from the columns intervening between the lacunæ. From the thickened polar epiblastic knob, the germinal area is formed by the separation of an

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ 'De Erfelijkheid van Verworven Eigenschappen,' 8vo, 'SGravenhage, 1890, pp. xiii. and 279.

§ Quart. Journ. Micr. Sci., xxx. (1889) pp. 283-404 (13 pls.).

internal bulging portion, which remains attached to the peripheral epiblast of the blastocyst along a circular line, until the amnion is formed. Soon after the establishment of the mesoderm, the separation of somatic and splanchnic layers is distinguishable, the former following the contours of the epiblastic disc, and folding up all along the circular attachment above mentioned. The epiblastic fold of the amnion is not double, but a single sheet, accompanying the double fold of mesoblast.

The germinal cell-mass bulges out gradually, leaving a central cavity, much in the same way as a morula becomes a blastula. The difference between this procedure and that described for the mole, rabbit, and opossum, is explained in reference to the fact that the cubic size of the hedgehog's blastocyst is many hundred times less than that of the others. As to physiological facts, Hubrecht maintains:—(1) That peculiar nutritive facilities are afforded by the didermic blastocyst before the formation of vascular areas on yolk-sac and allantois; (2) the "serous envelope," arising as a double layer of epiblast and mesoblast simultaneously with the amnion, does not as such take any important part in preparing the above facilities; (3) the outer cell-layer of the didermic blastocyst contributes very actively to bring them about; and (4) has an extensive and important rôle in perfecting the nutritive functions of the omphaloidean and allantoidean regions.

The author then introduces a series of new terms, by which he hopes to facilitate discussion. The trophoblast is the epiblast of the blastocyst so far as that has direct nutritive significance, as indicated by proliferating processes, and by immediate contact with maternal tissue, blood, or secreted material. The mesoblast, along with the trophoblast, forms the diplotrophoblast. That portion against which the vitelline circulation is applied is distinguished as omphaloidean from the mediodorsal allantoidean region. The omphaloidean placenta increases for a period, but retrogresses whenever the allantois begins to spread. Most important is Hubrecht's conclusion that both yolk-sac and allantois enter into very intimate interlocking, not with any maternal tissue, but with purely embryonic cell-material—the trophoblast—which has numerous lacunæ filled with maternal blood, and is connected with the maternal tissue long before the appearance of either vitelline or allantoidean circulation.

II. *The Histological Modifications in the Uterine Tissues.*—Where blastocysts are attached to the uterine wall, the lumina of the glands become occluded, the glandular epithelium gradually disappears, vascular channels and capillaries develope strongly. At first the blastocyst reposes at the bottom of a groove, in free communication with the lumen of the uterus, but the opposite walls of the depression fuse, a hæmorrhagic clot fills up the entrance of the cup thus formed, and the result is a capsule homologous with the *decidua reflexa* of the human subject. The blastocyst seems almost to eat its way into the maternal tissue, the uterine epithelium undergoing retrogressive metamorphosis. Round about the blastocyst, in the "vasifactive stroma" of the uterine mucosa, blood-spaces are formed in a unique fashion, and that region of mucosa undergoes proliferation and other changes, becoming the so-called "decidua." The zone of modified tissue with blood-cavities between the

blastocyst and the yet unaltered decidual stroma is named the trophospongia, while the embryonic trophoblast plus the maternal trophospongia, forming in *Erinaceus* a sphere shut off from the lumen of the uterus, is called the trophosphere. In this there appear certain specially large cells termed deciduofracts, the name suggesting their plausible function. While the author believes that trophospongia and deciduofracts arise from the endothelium of the blood-spaces of the decidual swelling, close to the blastocyst, he does not exclude the possibility that cells belonging to the decidual stroma may have a subordinate part in forming the trophospongia. The rest of this chapter is devoted to a consideration of the allantoidean trophospongia, the outer decidual layers, and the details of the mucosa.

III. *Physiology of Placentation.*—At a very early stage, the lacunæ of the blastocyst wall are filled with maternal blood, which contributes to growth and development. This primitive arrangement is succeeded by a very effective omphaloidean placentation, in which there is only a thin partition between the vitelline circulation and the maternal blood filling the trophoblastic spaces. This declines, however, as the final allantoidean placentation is established. The yolk-sac ceases to grow, and is folded up, although its circulation never wholly disappears; the trophoblast, against which it was applied, becomes membranous along with the rest of the omphaloidean trophosphere and the decidua reflexa. Of the vascular outgrowths of the allantois, as of those of the yolk-sac, it is true that they on no occasion penetrate or grow into maternal tissue. It is embryonic (trophoblastic) tissue that carries the maternal blood to them. The deciduofracts possibly act like phagocytes, with a direct destructive influence on the mucosa.

Prof. Hubrecht then reviews some recent contributions to the history of placentation, and urges against Sir William Turner, " that grand-master of placental research," four conclusions:—(1) In numerous orders (Carnivora, Chiroptera, Rodentia, Insectivora), the maternal epithelium disappears at a very early moment where the blastocyst adheres; (2) in the more primitive of the above orders, lacunar blood-spaces are in direct contact with the blastocyst long before the embryonic *area vasculosa* appears; (3) the connection between these lacunæ and the maternal blood-vessels is brought about in a more indirect way than by mere dilatation of capillary vessels; (4) in later stages, fœtal epiblast in varying thickness is present between the omphaloidean or allantoic villi and the maternal blood; in Insectivora, Chiroptera, Rodentia, this trophoblast is the only tissue so intervening. The author proposes to abandon the distinction between deciduate and indeciduate placentation, and maintains that the Insectivora furnish the natural starting-point for the placental series. After some observations on the ventral stalk (*Bauchstiel* of His), and other features in human placentation, Hubrecht concludes his elaborate memoir with a tabular comparison of the various names given by different investigators to placental structures.

Acquisition and Loss of Food-yolk, and Origin of the Calcareous Egg-shell.*—Mr. J. A. Ryder outlines his theory of yolk and shell. In primitive types which have ova almost wholly without yolk, surplus

* Amer. Natural., xxiii. (1889) pp. 928-33.

nutriment is elaborated into a multitude of small eggs, the number of which compensates for their unprotectedness. Unusual abundance of food might increase this number, or it might have the result of making the individual eggs larger, depositories for surplus oils and other hydrocarbons, buoyant like the pelagic ova of many fishes.

When the female parent becomes more highly developed, intelligent, circumspect, and alert, the ability to obtain food is doubtless increased, but as a matter of fact the ovary is reduced in size. The ova tend to be fewer and larger, and the circumspect parent retains them in the oviduct till their deposition is most convenient. When this retention is prolonged, as in Reptiles, a natural result is the deposition of albuminous or plasmic secondary deposits, or of secondary membranes, or even of a calcareous shell. But the secretory activity thus diverted from depositing surplus nutriment in the ovary would tend to diminish the fertility of the female and to starve the remaining ovarian ova.

Furthermore, if viviparous development occur, the embryo diverts all the spare nutriment to itself. The result is a diminution of fertility, a temporary check to the production of ova, but at the same time an increase in the chances of survival. This is most marked in cases of mammalian utero-gestation, when the claims of the fœtal parasite are strong, and when moreover the subsequent period of lactation tends to prolong the diversion of surplus nutriment from the ovary.

"It may be added, in conclusion, that the *membrana putaminis* of the eggs of birds and reptiles is a reticular, but cuticular, membrane, which is to be regarded as the homologue of the keratose cuticular secondary oviducal membranes of still lower forms, and that it would tend to take up calcareous matters in the same way as similar membranes in other parts of the body of a vertebrate."

Development of Proteus anguineus.*—Prof. R. Wiedersheim has had the opportunity of studying the development of *Proteus anguineus.* He finds that the external gill-orifices are ventral in position, and in young larvæ, as in Selachians, they are near the buccal cleft. The external gills first appear in the form of three papillæ set obliquely; later on they bifurcate and divide. The growing limbs have the form of buds, and call to mind the development of the paired fins of Teleosteans. The bend at the elbow-joint is to be seen in larvæ 16 mm. long. The position of the limb in relation to the wall of the trunk is such that the first finger is exactly ventral in direction, but the second dorsal. A short, broad tail is distinctly differentiated in larvæ 16 mm. long, and the fringe of fin that surrounds it is continued forwards, on the back, almost as far as the region of the neck. The organs of the lateral line are to be seen in larvæ 12 mm. long. The cœlom appears at 13 mm. in length, and the musculature is differentiated at the same stage.

The pronephros forms a compact coil of tubules which extends over three somites; it communicates with the cœlom by two infundibular orifices. The pronephros on either side and the ducts lie freely in wide venous blood-spaces which correspond to the system of posterior cardinal veins. Karyokinetic figures in the blood-cells indicate that division is going on in them. The enteric epithelium is capable of amœboid move-

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 121–40 (2 pls.).

ments, by means of which the yolk-elements lying in the lumen of the enteron are actively taken up.

The rudiments of the semicircular canals and the endolymphatic duct appear very early; and the same is true of the lungs. The olfactory sac and the auditory apparatus are strongly developed in compensation for the rudimentary condition of the eyes. The teeth are developed very early, and before any other hard structures appear in the head; each tooth arises, like the placoid scales of Selachians, on a free papilla. The cartilaginous primordial cranium does not differ in its development from that of other tailed Amphibia. An indication of a fourth epibranchial may be made out in the visceral skeleton.

Pronephros of Amblystoma punctatum.*—Mr. J. L. Kellogg reports that the first portion to appear is the segmental duct which arises from the somatic mesoblast. The anterior end of the duct becomes constricted off from the peritoneal epithelium, except at two points, where the nephrostomes are to open into the body-cavity. As the organ becomes older and the openings into the body-cavity are acquired, the nephrostomes become more and more funnel-shaped in outline. These nephrostomes are segmentally arranged. The glomerulus in *Amblystoma* appears much later than in the frog.

Egg-membranes and Micropyle of Osseous Fishes.†—Mr. C. H. Eigenmann has examined the eggs of various osseous fishes, which he arranges thus:—

I. Eggs with a single membrane, the zona radiata.
- *a.* Zona radiata a single layer of uniform structure. *Notemigonus* and *Carassius*.
- *a a.* Zona radiata differentiated into an inner and outer layer. *Morone*, *Esox*, &c.

II. Eggs with a zona radiata and a thin homogeneous outer layer.
- *b.* Outer membrane without appendages. *Clupea*.
- *b b.* „ „ bearing filiform appendages. *Fundulus*.
- *b b b.* „ „ with short appendages. *Pygosteus*.

III. Eggs with a zona and a thick outer layer produced by a secretion from, and metamorphosis of the granulosa cells. *Perca*.

The author agrees with those who regard the zona as being derived from the yolk, and in some points confirms the statements of Kölliker.

Development of Serranus atrarius.‡—Mr. H. V. Wilson has a preliminary notice on the development of the Sea Bass, the egg of which is not difficult to rear. This egg is small and pelagic, and has one oil-globule; in almost all segmentation is strictly regular and bilateral as far as the sixteen-cell-stage. When thirty-two cells are formed the blastoderm is no longer bilateral. By a process of excentric thinning out one portion of the blastoderm becomes thicker than the rest, and it is round a small arc of this portion that the germ-ring first begins to form. This ring is everywhere formed as an ingrowth of cells from the edge of the blastoderm, in which the superficial layer takes no part.

* John Hopkins Univ. Circ., ix. (1890) p. 59.
† Bull. Mus. Comp. Zool., xix. (1890) pp. 129–55 (3 pls.).
‡ John Hopkins Univ. Circ., ix. (1890) pp. 56–9.

When the embryonic shield has reached its full size, the primitive endoderm is composed of two layers of cells distinctly marked off, except in the middle line, where there is a fusion. The streak of fused cells presently acquires a sharper lateral boundary, and becomes the notochord. On each side the under of the two lateral layers grows beneath the notochord and, uniting with its fellow, forms the endoderm proper. The upper lateral plate thickens by cell-division and forms on each side the mesoderm plate. In the extreme anterior region the whole of the primitive endoderm becomes transformed into the mesoderm of the head.

The alimentary canal is formed by a process of folding, essentially similar to that found in the Amniota. Kuppfer's vesicle is not formed in a manner essentially different from that of the rest of the alimentary canal. The peculiar features of the vesicle are the size and early appearance of the fold, and (in pelagic eggs at least) the fact that the periblast is here pushed down. The characters of this vesicle are discussed at considerable length.

The Wolffian duct arises as a fold of the body-cavity, and at no time has any connection with the ectoderm; Brook, in the author's opinion, probably mistook for it the rudiment of the lateral line.

The development of the sensory organs and of the lateral line is next described, and the history seems to show that the superficial sensory patch found in larval fish does not represent the condition of the primitive segmental or branchial sense-organ. The author's account of the development of the lateral-line organs is radically different from that of Hoffmann, and lends no support to Eisig's view of the homology between the lateral-line organs of fishes and those of certain Annelids.

Karyokinesis and Cleavage of Ovum.*—Mr. S. Watase agrees with Van Beneden and Boveri in holding that the achromatic spindle plays the most important part in the production of the karyokinetic phenomenon. It is the mechanism by which the chromatic substance of the spindle is divided among the daughter-cells. But he cannot find any evidence of the contractility of the achromatic fibrils; on the other hand, he finds that the achromatic threads are constantly lengthening, stretching, and pushing away from the centres of the asters from which they start. The achromatic spindle in its perfected form consists of two cones with their bases turned towards each other, with a sheet, as it were, of the achromatic substance of the nucleus interposed between them. Each cone is a part of a more general system of radiating fibrils forming one of the asters. The asters in a cell arise from the preceding single aster, as the new nuclei arise from the preceding nucleus. The old aster divides into two, each daughter-aster having a granular substance in its centre, and around it the achromatic rays extending in all directions. As the rays from each of the small asters grow longer the centres of the corresponding asters become more and more widely separated from one another. A small achromatic spindle is formed by the two groups of achromatic rays between the two centres. When the two asters become so widely separated as to have the whole nucleus between them, they apparently come to rest and begin their work on the nucleus by pressing on the more solid portion of the nuclear contents. The

* John Hopkins Univ. Circ. ix. (1890) pp. 53–6.

formation of the equatorial chromatin-plate is solely due to the pressure exerted by the two systems of rays from the opposite sides of the nucleus. The separation of the equatorial plate into two daughter-plates travelling in opposite directions, and the formation of the interzonal filaments are due to the continuance of the same action which has been going on before—the continuous growth of the achromatic fibrils. When each of two daughter-chromatin-plates approach the extremities of the spindle a new nuclear membrane is formed around each chromatin-plate, each plate thus forming a complete nucleus. The interzonal filaments consist of the same substance as the spindle filaments, but they do not in any way unite two daughter-chromatin-plates. In the interzonal filaments, therefore, there are two systems of filaments which run in opposite directions.

Looking at it in this way, the author considers that the whole phenomena of karyokinetic changes may be connected in one continuous series of activities of the cytoplasmic asters upon the nucleus. It follows that the rapidity of the cleavage process depends, in a great measure, upon the rapidity with which the cytoplasmic asters can migrate to two opposite poles of the nucleus. The presence, therefore, of inert, passive yolk-glanules imbedded in the cell-body of the ovum, necessarily interferes with rapid movement of the cytoplasmic asters. Such a view of the mechanism of karyokinesis suggests an explanation of the well-known fact, that the velocity of cleavage in any part of the ovum is, roughly speaking, directly proportional to the concentration of the protoplasm, or inversely proportional to the quantity of yolk-granules imbedded in the protoplasm.

The mechanism involved in the multiple nuclear division can be explained exactly in the same way as that in the binary karyokinesis. If, in a given stage of cleavage, say in the eight-cell stage, one blastomere on the right-hand side of the bilateral ovum shows multiple karyokinesis, the corresponding segment on the left half of the ovum shows exactly the same peculiarity.

β. Histology.*

The state in which the Water exists in Live Protoplasm.†—Prof. Marcus M. Hartog remarks:—One consideration on the structure of protoplasm, the question of the mode in which its water is combined with it, has been somewhat neglected of recent years. Even Berthold, who in his 'Protoplasma-mechanik' ‡ has put forth a masterly exposition of the reasons for regarding living protoplasm as an emulsion, seems to have overlooked the need of explaining the condition of what may be termed the substratum or base of the emulsion in which the droplets lie.

Yet there is one phenomenon which ever confronts the histologist and sheds considerable light on this question, and which, from its very obviousness, has hitherto escaped full investigation; this is the change of optical behaviour of the protoplasm after death. Living protoplasm, in which I include even such specialized forms as striated muscular fibre, is transparent, with a refractive index not far above those of water, cell-sap, or the liquids that lave the cavities of the Metazoa. The difference

* This section is limited to papers relating to Cells and Fibres.

† Read at the British Association, 1889. ‡ Leipzig, 1886.

is so slight as to make small animals transparent, a very obvious phenomenon in the case of rounded pelagic animals, freshwater or marine. It is only by *slight* differences of refractivity, often requiring accentuation by oblique illumination, that we show up the different structures and cavities in these, in optical sections under the Microscope. Exner has recently determined the refractivity of striated muscle in *Hydrophilus* at $\mu = 1 \cdot 363$, in the frog at $\mu = 1 \cdot 368$,* while that of water is $\mu = 1 \cdot 333$, that of the liquid of an ovarian cyst is $\mu = 1 \cdot 365$, synovia $\mu = 1 \cdot 348$, egg-albumen (fresh) $\mu\, 1 \cdot 359$–$1 \cdot 364$.†

Immediately on death, however, this transparency disappears, and dead protoplasm is notably opaque. Now opacity can only be due to one of three causes: reflection at the surface, as with metals; absorption in the substance, as with ink; or scattering of light due to optical heterogeneity, like spun glass in the skein, silicate wool, filter-paper, &c. The two former causes are excluded by the nature of the case; and the last, *optical heterogeneity*, is left to us as the only possible explanation. Now we can make the paper transparent by greasing it, and so replacing the air in its interspaces by a medium approaching cellulose in refractivity; just so do we "clear" or restore the transparency of our dead protoplasm by replacing the aqueous medium that permeates it (and which can be expelled by pressure), with one of higher refractive index such as glycerin ($\mu = 1 \cdot 462$), or Canada balsam ($\mu = 1 \cdot 52$).‡ Yet even the latter falls below that of the dead protoplasm, as is very obvious in balsam mounts of transverse sections of muscle, or the spores of Saprolegnieæ, and I think their index is not much under $1 \cdot 55$.

It is obvious that the watery liquid which permeates dead protoplasm (consisting of water + small quantities of soluble salts) exists in a separate liquid condition in the interstices of a solid material, and that these interstices are too fine to be directly visible by the highest powers of the Microscope. This solid material has lost the power which it possesses in life of taking water into its substance. Exner has shown that living muscular fibre can excrete part of its liquid with corresponding increase of refractivity, and he cites the observation of Künckel that it can take up an additional 20 per cent. of water.

It follows that the water in living protoplasm must exist in a state of perfect physical combination, like the water of a solution of gum or of jelly. Now the phenomena of protoplasmic motions, as studied in the Rhizopods and in the vegetable cell, seem to me absolutely to preclude the jelly supposition; and for these cases we must admit that living protoplasm is a viscid liquid, whose refractivity is probably the mean of the two constituents separated by death, the one solid, the other a watery solution; and death is for us essentially a phenomenon of precipitation.

I may summarize these conclusions in the following theses:—

I. Live protoplasm is transparent and of low refractivity ($\mu < 1 \cdot 38$).

II. Dead protoplasm is opaque from optical heterogeneity.

III. The transparency of dead protoplasm is restored by replacing the liquid that permeates it by a medium of higher refractive index.

* In Pflüger's Arch., xl., "Ueber optische Eigenschaften lebender Muskelfasern."

† Exner in Arch. f. Mikr. Anat., xxv., "Ein Mikro-Refractometer," p. 111.

‡ This explanation of clearing was first given in part by A. B. Lee ('Microtomist's Vade-Mecum,' 1st ed., p. 213).

IV. The substance so permeated is solid and of high refractivity ($\mu > 1 \cdot 53$).

V. In death the solid substance forms a sort of reticulum too fine for resolution by our Microscopes,* the interstices of which are permeated by the watery liquid; in life the two are physically combined in the form of a viscid liquid. Hence death is essentially a phenomenon of precipitation.

For the more exact solution of the points discussed above, I propose making a full research on the refractivity of various proteids, solid and in solution, and of living and dead structures, animal and vegetable. The method I shall follow is that adopted by Exner in the papers cited above, consisting in immersion in liquids of known refractivity, and examination under the Microscope with the micro-refractometer which he invented.

It may be of interest to add that the above ideas were suggested to me in elaborating a technique for the convenient study of the Saprolegnieæ.

Peculiar Polycentric Arrangement of Chromatin.†—Dr. O. vom Rath calls attention to a peculiar polycentric arrangement of chromatin which he noticed in some large gland-like cells of *Anilocra mediterranea.* These cells were found in various parts of the head, and the author is inclined to believe that they have a salivary function. The cells varied considerably in size and form. The cell-protoplasm has in most cases the appearance of a finely granular coagulation, in which a very fine multireticulate plexus may occasionally be made out. In most cells there are several nuclei, and they may be of very different sizes. Some are round, others oval, others sausage-shaped, biscuit-shaped, or constricted. The chromatic star-figures exhibit a polycentric arrangement of the chromatin of the nuclei; each of these figures consists of an intensely coloured centre and a number of radially arranged, somewhat brightly-coloured chromatin-rods. The centre generally appears to be homogeneous, while in very thin sections it has not rarely the form of a dark ring with a clear central internal space. All the chromatin-rods are considerably thinner at the end which is turned towards the centre than at the other, which is somewhat swollen. At first sight there does not seem to be a direct connection between the chromatin-rods and the centre, but the use of higher powers (Seibert's apochromatic homog. immers. N.A. 1·35, oc. 8) shows distinctly that the club-shaped chromatin-rod is continued, at its central end, into a thin, pale filament which extends to the dark centre. The chromatin-rods surround the centre in all directions like the spines of a sea-urchin.

In nuclei with one star the centre of the nucleus and of the star fall together; but when there are several stars the centre of each is about the length of the radius of a star from the periphery of the nucleus. From the peripheral end of the several chromatin-rods, very pale, fine filaments pass out; these unite the chromatin-rods of the same star with one another, and with those of the neighbouring stars; in this way a plexus is formed which traverses the whole nucleus.

* Of course this is quite distinct from the much coarser reticulum or sponge directly visible under the Microscope.

† Zool. Anzeig., xiii. (1890) pp. 231–8 (1 fig.).

The unusual size and the forms of the nuclei, and especially the presence of figures of direct nuclear development, together with the presence of several nuclei in one cell, are all characters which have been noted in cells which have an intense secretory or assimilating function; the peculiarity of the present case is the arrangement of the chromatin. In the absence of any knowledge of similar cases it is difficult to suggest what this means. One is inclined to regard the chromatic centres of the star-figures as themselves nucleoli, around which the chromatin has, from some cause, become radially arranged. It has long been known that a large number of nucleoli may be found in gland-cells, and, indeed, in some other kinds of cells too. It is possible that the phenomenon has something to do with multipolar indirect cell-division; we might imagine that each centre was a centrosoma, and regard the division of the centres as divisions of centrosomata; but to this supposition it is easy to raise objections, and, at present, the best way of finding an explanation is to multiply examples of this peculiar mode of arrangement.

Micrometric Study of Red Blood-corpuscles.*—Prof. M. D. Ewell has made an elaborate micrometric study of blood, which is one of the few methods of identifying that fluid which is worthy of discussion. No reliance can, however, be placed on the micrometric test unless the errors of the micrometer used, with reference to some authentic standard, are known. When the subject continues during a short period in substantially the same condition of good health, there appears in the hands of the same observer to be an average size of the fresh corpuscles, provided at least one hundred are measured. As several tables given by the author show, there are such large discrepancies between the averages obtained from the measurement of the fresh blood-corpuscles of animals of the same species, and between measurements of the same objects by different observers, as to throw doubt on published results. There is no advantage in using very high powers in these investigations. The drying of blood-corpuscles in a clot multiplies the difficulty of identification; it has never been proved that dried corpuscles can be restored to their normal proportions. The mean size of the red corpuscles of very young animals is larger, and their size varies between wider limits than in adults. Many diseases alter the size of the red corpuscles, and fasting and various drugs diminish both their size and number. It is impossible, therefore, in the present state of science to say more of a given specimen of blood, fresh or dry, than that it is the blood of a mammal.

Histology of Central Nervous System.†—Prof. A. Kölliker, in his first communication on this subject, deals with the minute structure of the cerebellum. He finds that the granular layer contains a few glia-cells, and a large number of multipolar nerve-cells—the small and large granular cells. The former are very numerous, and have short protoplasmic processes, which divide at the end into small tufts. The very fine nervous process generally arises from a protoplasmic process, passes into the molecular layer, and then divides into two horizontal and longitudinal unbranched fibrils, the termination of which is unknown. There

* North Amer. Practitioner, ii. (1890) pp. 99–107, 173–86.
† Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 663–89 (4 pls.).

are a large number of them, and they give the appearance of an extremely close parallel striation to vertical longitudinal sections. The large granular cells are more scattered and rarer; they have numerous ramified protoplasmic processes, which pass into the molecular layer, and also into the medullary lamellæ. The nervous processes of the cells of Purkinje give off a moderate number of fine lateral branches, some of which return to the molecular layer. The smaller cells of the molecular layer are external or internal; the former have richly branched protoplasmic processes, which often extend for a considerable distance, and a nervous process, the exact relations of which are unknown. The latter have very long and well-branched protoplasmic processes, some of which reach to the outermost parts of the molecular layer. The nervous process is very long, and extends as a transverse fibre over the bodies of the cells of Purkinje, and gives off, from time to time, vertical processes which pass inwards; these divide and surround the cell-body like basketwork.

The medullated fibres of the cerebellum of adult animals divide in the molecular layer only; they form a thick plexus in the granular layer. In the brains of embryonic and young mammals the medullary lamellæ of the cerebellum exhibit a certain number of undoubted nerve-fibres, which divide and become lost in the two layers of the grey substance, where they form anastomosing arborescent divisions. None of the fibrous structures revealed by Golgi's methods give certain indications of anastomoses, and as yet there is no fact that justifies us in believing in the presence of a nervous network in the grey substance.

Does a Magnet affect Karyokinesis? *—M. L. Errera, like many other observers, has been impressed by the resemblance between some karyokinetic figures and magnetic curves. He was led to try whether an electromagnet had any influence on the dividing nuclei in the staminal hairs of *Tradescantia virginica*. But the currents of protoplasm persisted, and the karyokinesis proceeded quite normally, so that the result of the experiment was distinctly negative.

γ. General.

Origin of Nerve-centres of Cœlomata.†—M. L. Roule discusses this question, and comes to the conclusion that in the Trochozoa (Mollusca and Annelida), and, without doubt, in the Chordata also, the nerve-centres of the adult, which are arranged in a bilaterally symmetrical manner, are always derived from simple and median rudiments, which are subsequently divided into two lateral symmetrical halves, and that they are not formed from the junction of two primitively distinct rudiments. When the larva has a proper nervous system, this is sometimes arranged radially (Trochozoa), and sometimes longitudinally (Chordata). In the former case the greater part of the system disappears, while what remains becomes the rudiment of the nerve-centres of the adult, or put themselves into relation with rudiments formed directly by the ectoblast; in the latter case the nervous system is preserved entire, or parts disappear, as in the tail of the caducichordate Tunicata.

* Bull. Soc. R. Bot. Belg., xxix. (1890) pp. 17–24.
† Arch. Zool. Expér. et Gén., viii. (1890) pp. 83–100.

"British Area" in Marine Zoology.*—Canon A. M. Norman has an interesting paper on this vexed question. He defines it as bounded on the south by 49° 30′ N., terminating at 5° 0′ W.—that is, midway between the Land's End and Brest. The mid-channel should be the boundary round the south and south-east coast, until, nearly opposite the Naze, we obtain a mid-channel at 2° 30′ E., and that longitude may be taken as the boundary through the North Sea and past Shetland. The northern boundary is more complex; it may start from the west at 60° N., and proceed eastwards till a point about midway between Cape Wrath and Faroe is met at 5° 0′ W.; thence a line should be taken due north-east past Shetland, until 1° 0′ W. is reached, whence the line should go due east to 2° 30′ E. The western boundary has no limits; it is the slope of that part of the continent of Europe of which our islands are the outliers, and descends to the base of the continent at 1500 fathoms. The author details his reasons for suggesting these boundaries, and criticizes the report of the British Association (1888) Committee, of which he was chairman, but to which at the time he was not able to give the necessary attention.

B. INVERTEBRATA.

Marine Invertebrate Fauna of the Gulf of Manaar.—In a report on the Pearl and Chank Fisheries,† published by the Government of Madras, Mr. E. Thurston gives a preliminary account of the marine fauna of the Gulf of Manaar; the sponges, echinoderms, Crustacea, and Mollusca have been worked out by specialists; there is also a list of the Cœlenterata.

New Invertebrates from the Coast of California.‡—Mr. J. W. Fewkes gives descriptions of various new genera and species of Invertebrates, which he collected off the coast of California; especial attention was directed to the Medusæ.

Heliotropism of Nauplii and Movements of Pelagic Animals.§—Mr. T. T. Groom and Dr. J. Loeb have made a number of experiments on the Nauplii of *Balanus perforatus* with the object of testing their heliotropism and of investigating the causes of the migrations of pelagic animals to or from the surface of the sea. They come to the conclusion that the periodical daily migrations of pelagic animals are due to heliotropism, or, in other words, are directed by the rays of light; this heliotropism is in the evening (in faint light) positive, and in the morning (in strong light) negative. The directive influence of a source of heat is slight in comparison with that of a source of light, so that the heating of the surface by day and its cooling by night do not play any essential part in the periodical migrations of animals.

Mollusca.

Revision of British Mollusca.‖—The Rev. Canon Norman has commenced the publication of a revision of British Mollusca. In the present paper the Cephalopoda are dealt with, and a new arrangement of the group is proposed. It is based primarily upon sexual distinctions. The

* Ann. and Mag. Nat. Hist., v. (1890) pp. 345–53 (1 map).
† Madras, 1890, 8vo, pp. 69–89.
‡ 'Zoological Excursions,' i., Boston, 1889, 8vo, 50 pp., 7 pls.
§ Biol. Centralbl., x. (1890) pp. 160–77; 219 and 20.
‖ Ann. and Mag. Nat. Hist., v. (1890) pp. 452–84.

Mesarsenia have the third arm of the male hectocotylized, while some of the suckers of the other arms are in that sex much larger than those of the female, in certain genera; in others the tips of the arms undergo modification; here come the Octopoda. The Decapoda are divided into the Chondrophora, Sepiophora, and Phragmophora; the first of these groups consists of two suborders—the Ophistharsenia (= Sepiolidæ), in which one of the first or dorsal arms is generally hectocotylized, and the Prostharsenia (= Cranchiidæ, Chiroteuthidæ, Ommastrephidæ, and Loliginidæ), in which there is hectocotylization of one of the fourth, i.e. ventral arms. In the Sepiophora (= Sepiidæ) and the Phragmophora (= Spirulidæ), the hectocotylization is on the basal portion of the fourth or ventral arm. The synonymy and distribution of twenty species are given.

Terrestrial Air-breathing Molluscs of United States.*—Mr. W. G. Binney has published a third supplement to his fifth volume on these Molluscs, in which the eastern province species are given as well as other addenda which bring the subject down to the first day of this year. *Arion foliolatus* Gould has been rediscovered, after fifty years' disappearance.

γ. Gastropoda.

Nudibranchs collected by the 'Blake.'†—Dr. R. Bergh gives an account of the seven, all new, Nudibranchs collected by the U.S. steamer 'Blake' in the Gulf of Mexico and the Caribbean Sea. Opportunity is taken to revise or make additions to the characters of the genera. *Chromodoris scabriuscula* is remarkable for the hard warts on the back and the development of the cutaneous spicules, as well as for its strong median tooth-plates. A species which is called *anceps* is, with some doubt, assigned to the genus *Phlegmodoris*. The anatomy of all the species is very carefully detailed.

The "Opaline Gland" of Aplysiidæ.‡—To a previous report § of Sig. G. F. Mazzarelli's investigation of the "opaline," "poison," or "grape-like" gland of Aplysiidæ, the following facts from the completed memoir may now be added:—The gland of Bohadsch, as the author prefers to call it, usually receives an arterial trunk directly from the aorta, and is always innervated from the right pedal ganglion. It may consist of odoriferous, chromatogenous, and giant mucous cells, derived from a gradual increase and modification of ectodermic elements which sink into the subjacent connective and muscular mesoderm. According to the nature of the component cells, the gland may emit a white and odoriferous, a violet, or a mucous section, of which the first and third are usually combined in all the species, while the second is only known in *Aplysia limacina* and *A. punctata*. There is, however, great variability in the character of the secretion. The products of the gland are regarded by Mazzarelli as excretory, while he believes that their odour and their power of clouding the water have a defensive value. Morphologically, the organ is probably comparable to a glandular sac recently described in *Oscanius* (*Pleurobranchus*) by A. G. Bourne.

* Bull. Mus. Comp. Zool., xix. (1890) pp. 183-226 (11 pls.).
† T. c., pp. 155-81 (3 pls.).
‡ Mem. Estr. Atti R. Accad. Napoli, iv. (1890) pp. 26 (2 pls.).
§ This Journal, 1890, p. 164.

δ. Lamellibranchiata.

Two new Hermaphrodite Lamellibranchs.*—M. P. Pelseneer justly directs attention to the rare condition of hermaphroditism exhibited by two Lamellibranchs. In some species of *Pecten* there is hermaphroditism, but one part of the gonad is male, and another female; *Pandora* and *Aspergillum* have on each side two distinct gonads, one male and one female, and each with its own duct. In *Lyonsiella* there are two ovaries and two testes, and the same is the case with *Poromya*, though the arrangement of the ducts is different.

It is remarkable that all the Lamellibranchs which have the sexes united belong to groups in which there is a good deal of specialization, such as the Pseudolamellibranchiata, the Eulamellibranchiata, and the Septibranchiata; on the other hand, the more primitive forms are all diœcious. As this is true also of Gastropoda, we may conclude that in the ancestors of the Mollusca the separation of the sexes was the normal arrangement, and that hermaphroditism is a sign of specialization.

Molluscoida.

α. Tunicata.

Anatomy of the Cynthiidæ.†—Profs. H. de Lacaze-Duthiers and Yves Delage publish some preliminary notes on the anatomy and systematic relations of the Cynthiidæ. The pyloric gland is present in all members, whether there be a liver, as in the Cynthiineæ, or no such definite organ, as in the Styelineæ. The authors believe that the pyloric gland has a special digestive secretion, but with this an excretory function is possibly combined. They leave the last point to be worked out by Kowalevsky. The classification of Cynthiidæ requires revision, and in distinguishing Cynthiineæ from Styelineæ the chief emphasis should be laid on the alimentary system.

The Cynthiineæ have a distinct liver. The stomach is unswollen, without distinct limits, without marked internal projections, without a stomachal gutter, without an intestinal-pyloric ligament conducting the excretory duct of the pyloric gland, which opens directly on the wall of the digestive tube. The digestive loop is very large, extending almost to the level of the inhalent aperture; it consists of two portions almost vertical and parallel throughout the greater part of their length. The species are always armed with spicules. The dorsal raphe bears languets, or a continuous lamella.

The Styelineæ have no distinct liver. The stomach is swollen, definitely limited from œsophagus and intestine. It bears marked internal projections, and a deep gutter ending in a *cul-de-sac*, in which the excretory canal of the pyloric gland opens, after following the course of the intestinal-pyloric ligament. The intestinal loop is almost transverse, and hardly extends above the level of the cloacal aperture. The species are usually unarmed, though sometimes slightly. The dorsal raphe always bears a simple continuous lamella.

* Comptes Rendus, cx. (1890) pp. 1081–3.
† Arch. Zool. Expér. et Gén., vii. (1889) pp. 519–34 (1 pl.).

β. Bryozoa.

Synonymic Catalogue of Recent Marine Bryozoa.*—Miss E. C. Jelly is to be congratulated on the completion of this most valuable work. Though it is not to be expected that her fellow-workers will in all cases agree with her in her views of synonymous names, they are all greatly indebted to her for the long and patient labour necessary for a work of this kind; in many cases a single species occupies more than a page, and sometimes nearly two. When a recent form is also known in the fossil state, references to the fossil specimens are given. Only a systematist will fully appreciate the service Miss Jelly has performed for students of the Marine Bryozoa.

South Australian Polyzoa.†—Mr. P. H. MacGillivray in presenting a list of sixty-four species of South Australian Polyzoa, four of which are new, points out that the Australian seas are peculiarly rich in Polyzoa, more than 360 having been recorded from Victoria. Other parts of South Australia are, probably, equally rich.

Arthropoda.

Migration of Retinal Area in Arthropods.‡—Mr. G. Watase discusses the migration of the retinal area and its relation to the morphology of the simple ocelli and the compound eyes of Arthropods. He defines an ocellus as a visual organ in which the sensory nerve-end cells are segregated into definite groups called retinulæ, a group of retinulæ being again characterized by possessing a single dioptric apparatus in common. The author has already pointed out that a single retinula is morphologically a pit-like invagination of the skin. In his present paper Mr. Watase proposes to show how, granting the homology of the retinulæ in both the compound and simple eyes, a group of such retinular invaginations becomes again invaginated as a whole.

An area of primitive pit-organs which probably occupied the level of the general body-surface may migrate, under certain circumstances, inwards into the body in an embryonic stage. Since a slight difference in the level of a sense-area, in reference to the level of the surroundings, introduces a fundamental difference in the formation of the dioptric mechanism of an Arthropod, and, therefore, presumably a difference in functions, two organs serving different purposes may easily be formed out of the common type from a circumstance comparatively insignificant at first. The composite mode of origin of the visual organ in Arthropods culminates in the remarkable phenomenon of migration of the sensory area of the eye first observed by Brookes and Bruce in the larva of *Limulus*. Strictly speaking, the early stage of the lateral eye of *Limulus* represents a structure which is neither a compound eye nor a simple eye, but the initial stage for both. The author does not look favourably on theories which derive the compound from the simple eye. Both types are considered to have been derived from a common source—a group of pit-organs arranged on the level of the surface of the body.

* 8vo, London, 1889, 322 pp.
† Trans., Proc. and Rep. Roy. Soc. South Australia, xii. (1889) pp. 24–31 (1 pl.).
‡ John Hopkins Univ. Circ., ix. (1890) pp. 63–5 (2 figs.).

"They are the differentiations into two different directions from a common starting-point, the initiating factor for this divergence being the relative differences of the levels of the primitive sense-areas, in reference to the level of the surrounding skin."

α. Insecta.

Eyes of Caterpillars and Phryganid Larvæ.*—Herr O. Pankrath has examined the eyes of the caterpillars of *Gastropacha rubi*, and of the larvæ of the Phryganida. As is well known these eyes do not, as a rule, survive in the adult, for they disappear during the pupal stage, and are replaced by perfectly new organs. It may be supposed, *à priori*, that the same components are found in both sets of eyes, and a simple eye of a larva may well be compared with a facet of an adult's eye. This facet consists of a cornea-lens, a crystalline cone, and a retinula, which, as a rule, consists of seven parts; there are just the same components in the eye of a caterpillar; the fact that there are also seven rods in the retinula is probably not an accident, but indicates the close connection between the two kinds of eye.

Notwithstanding this resemblance there is a great difference in the vision of the caterpillar and the butterfly. In the latter a number of facets act in conjunction, and the eye is adapted for the perception of movements; in the caterpillar each eye acts independently, and is rather adapted for the perception of bodies. The powers of such an eye are, in consequence of the small number of nerve-endings, very small, but it is probable that they can do more than distinguish between light and darkness, and are able to perceive bodies, though not to distinguish them.

Intermediate stages can be easily detected between the two extremes; if the eye of a caterpillar be more closely approximated and covered by a continuous cornea, we get the eye of the Phryganid larva; while, if the separate eyes in this organ be multiplied and set closer together, we get the facetted eye, for this last is nothing more than a complex of a number of separate eyes.

Diminution in Weight during Pupation.†—Herr F. Urech shows, by means of curves, the gradual diminution of weight throughout the pupal stage of *Pieris* (*Pontia*) *brassicæ*. The various curves express the influence of the different temperatures at which the pupæ were kept, in the open air or within doors. They show very vividly that the weight diminishes with great rapidity towards the end of pupation, and also that dry air shortens the length of the period. The loss is of course due to the internal metabolism of the pupal reconstruction which goes on without recuperative income. Of the water given off along with carbonic dioxide, part is directly associated with the continual oxidation, the rest forms a large proportion of the secretion exuded before the emergence of the imago. Herr Urech also gives a table showing the rapidity with which the wings grow after emergence.

Tracheal Endings in Sericteria of Caterpillars.‡—Dr. C. v. Wistinghausen has investigated the mode of termination of the tracheæ

* Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 690–708 (2 pls.).
† Zool. Anzeig., xiii. (1890) pp. 254–60.
‡ Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 565–82 (1 pl.).

in the sericteria (spinning-glands) of caterpillars. The tracheal capillaries do not, he finds, end in the sericterial cells, but pass into a fine plexus—the so-called tracheo-capillary plexus. This is a system of fine tubes which, like the tracheal capillaries, consist of a peritoneal layer and an intima, which is probably chitinized; the tubes anastomose with one another, and the capillaries of various tracheal areas are connected with one another. The plexus lies beneath the membrana propria and between it and the sericterial cells, and broadens out over the whole cell; it does not, however, lie in the plasma of the cell, but is separated from it by a thin membrane.

Secretion of Silk by Silkworm.*—Prof. G. Gilson is of opinion that the silk of the silkworm is a regular secretion product. He bases this view on the facts that—the glandular tube is covered internally, through its whole length, by a transparent membrane; this contains circular threads, and the spaces between them are filled with a network-formation. As the silk is always separated from the cells by a membrane, it cannot be the result of the direct transformation of the protoplasm. In the next place, the silk is not, as a rule, to be detected by any reagents in the body of the cell, but in some cases it becomes really visible. At the end of larval life, certain shining spherules were found in the cells, and the reactions of these were just the same as those of silk. If one impedes the excretion of the silk at the end of larval life, the cell-body becomes quite burdened with silk-spherules. It seems that the silk is made up within the protoplasm, and cast out through the meshes of the netlike membrane. A selection is probably made by the membrane itself among the several substances that are mixed with the liquid part of the protoplasm and the silk, and the substance that becomes the silk is cast out. The special apparatus of the silk-duct seems to regulate the diameter of the thread, which is often very irregular before it has passed through it, and probably also to regulate the thickness of the thread.

Development of Hydrophilus piceus.†—Dr. V. Graber has a critical notice of Dr. K. Heider's memoir on the development of *Hydrophilus piceus*. Objection is raised to the statement that the primitive segments in Insects never enter into any relation with the rudiments of the extremities, and *Stenobothrus* is cited as a case. In other cases Dr. Heider is stated to have reported on what happens in *Hydrophilus* as if the facts were noted by him for the first time.

Development of Chalicodoma muraria.‡—Dr. J. Carrière has published a full account of the development of this bee. The egg is sausage-shaped, and the concave side is the dorsal. It is particularly well adapted for study, not only because of its transparency, but because the whole process of development is effected on the future ventral side. Several periods may be distinguished during development within the egg; the first closes with the formation of the germinal membrane, the second contains the changes which occur from the commencement of the formation of the germinal layers till the complete closure of the embryo

* Rep. Brit. Assoc., 1889 (1890) pp. 628–9.
† Zool. Anzeig., xiii. (1890) pp. 287–9.
‡ Arch. f. Mikr. Anat., xxxv. (1890) pp. 141–65 (1 pl.). See this Journal, *ante*, p. 322.

and its regular segmentation, while the third begins with the appearance of the rudiments of the gnathites, and ends with the formation of the anus; the fourth includes the rest of the intraovular development.

It should be noted that all of the so-called yolk-cells do not come to the surface in the formation of the blastoderm; much remains behind in the yolk. It is quite easy to see distinctly in *Chalicodoma* that, later on, there is neither a migration of yolk-cells into the already formed blastoderm or into the meso- or endoderm, or, on the other hand, a return of the cells of these layers into the yolk.

The Poison and Sting of the Bee.*—Dr. G. Carlet finds that in Hymenoptera with toothed stings there is in addition to the well-known "acid-gland" another with an alkaline secretion which renders the poison fatal. In Hymenoptera with smooth stings, which benumb their victims without killing them outright, this extra "alkaline gland" is rudimentary or absent. He describes the piston which makes the sting a double syringe, and shows how the cistern of poison feeds the syringe in such a way that the secretion does not flow out unless the whole apparatus is brought into action. The articulation of the stilets is the same in principle as the cabinet-maker's sliding dovetail. Of the detailed parts of the sting, the author claims to have given a more exact account than heretofore, of the truth of which Mr. Cheshire can judge.

The Genus Prosopistoma.†—M. A. Vayssière begins a monograph on this interesting Ephemerid, which has received such varied treatment at the hands of naturalists. Of the European species *P. foliaceum*, the male adult is still undiscovered, while the Madagascar forms (*P. variegatum*) are known only in the "larval-nymphal" stage. The young forms of the European species live in rapid rivers, such as the Seine and Rhône, under stones, in company with small insect larvæ. They swim rapidly, avoid the light, and probably feed on Protozoa and organic débris. Making a sort of sucker of their body, they also adhere firmly to the surface of stones. In swimming they use chiefly the three hairy bristles at the posterior end, while the head seems to be directive. The habits and the frequent moults of the "larval-nymphal" forms were studied by M. Vayssière on captive specimens. So far, the author describes the tegumentary, muscular, alimentary, and vascular structures, but the general results may be reserved until the completion of the monograph.

Anatomy of Thysanura.‡—Mr. H. T. Fernald gives an abstract of his studies on Thysanuran anatomy. *Anurida maritima* has been fully examined, and in some points *Lepisma saccharina*. The structure which Sommer called the "Excretionsorgan" in *Macrotoma* is present in *Anurida*, and is regarded by the author as the homologue of the fat-body of higher insects; its connection with the hypodermis is only secondary. Near the origin of each of the main nerve-trunks there lies a very large nucleus, which is more than twice the size of the nuclei of nerve-cells, but the author has not been able to ascertain its significance. Tactile bristles are scattered over the surface of the body, and are especially abundant on the antennæ and round the mouth. On the terminal joint

* Ann. Sci. Nat. (Zool.), ix. (1890) pp. 1–17 (1 pl.). † T. c., pp. 19–64 (1 pl.).
‡ John Hopkins Univ. Circ., ix. (1890) pp. 62–3.

of each antenna there is a small trilobed organ, which is similar to the bilobed organ described by Kingsley in *Campodea*; it probably aids in the determination of the form of the objects touched by the antenna. There are five eyes on each side of the head, and each of these consists of a nearly spherical mass of protoplasm containing four nuclei and covered externally by the cuticula, which is here smooth, though bearing small protuberances elsewhere. Immediately below the protoplasm is a dense layer of pigment. The different eyes of each side are entirely independent, and lie some little distance apart. No structure resembling an ommatidium could be found.

The post-antennal organ described by Laboulbène is situated between the eyes and the base of the antenna, on each side of the head. It is a rosette-like structure, and consists of from seven to nine ovoid bodies radiating from a centre. At the central end of each is a sort of pedicel or stalk joining the ovoid portion to the head. Both parts of the organ are filled by a pigmented protoplasm continuous with the hypodermis, but no nerve-connection was observed.

The abdominal vesicle is cleft longitudinally, and the hypodermic cells lining the cleft are glandular in appearance and are larger than on the outer sides of the vesicle. A small tube, in the formation of which both hypodermis and cuticula take part, passes forward in the ventral line to a median cleft in the lower lip. From the salivary glands a duct, which soon fuses with its fellow, passes forwards, but, instead of emptying into the mouth, it joins this ventral tube.

In *Lepisma* each eye consists of twelve facets, and each ommatidium consists of a large cornea, beneath which are two corneagen cells; the crystalline cone has the form of a concavo-convex lens, and at its sides are the four cells of the vitrella. The rhabdomere is pyramidal, and its base rests against the internal face of the crystalline cone; the four retinulæ which surround it are densely pigmented, and their proximal ends, which perforate the basement membrane, become optic nerves. *Lepisma* seems to represent the highest grade of differentiation yet attained by the Thysanura, while *Anurida* seems to have undergone a differentiation perhaps even greater, but followed by a degradation which is probably correlated with a change of habits and food.

β. Myriopoda.

Anatomy and Histology of Digestive Tube of Cryptops.*—M. E. G. Balbiani gives a detailed account of the general and minute anatomy of the digestive tract of this Myriopod. He was led to study it by remarking that the œsophagus, and not the intestine, is the region chiefly selected by the parasites which infest it. The author enters into a very minute account of the object of his investigation.

γ. Prototracheata.

Australian Species of Peripatus.†—Mr. A. Dendy has come to the conclusion that only one species of *Peripatus*—*P. leuckarti*—has as yet been found in Australia. Owing to the very distinct and definite mark-

* Arch. Zool. Expér. et Gén., viii. (1890) pp. 1–82 (6 pls.).
† Proc. Roy. Soc. Victoria, 1889 (*sic*), pp. 50–62.

ings in two specimens found by himself in Victoria, he was at first inclined to think that he had discovered a new species.* The close and critical examination of the colour markings which he has since made has shown him that this is not the case.

δ. Arachnida.

Lung of Arachnida.†—M. L. Berteaux has made a study of the lungs of Arachnida. He describes the upper surface of the pulmonary plates of the dipneumonous forms as being covered with chitinous tigella with free ends; these tigella are united at their base by a plexus with polygonal meshes which is formed by the cuticle. In *Mygale* the tigella anastomose at their tops, and the whole constitutes a trellis-work.

The free edge of the plates of the Dipneumona has a "marginal palisade" formed of anastomosed tigella. In *Euscorpius flavicaudis* the structure of the pulmonary plates is almost exactly like that of the dipneumonous spiders. In *Buthus europæus* the two lamellæ which form a plate carry the same chitinous processes; in *Scorpio indicus* the plates are divided into two zones, one of which is naked, while the other carries spines which are analogous to those of the Dipneumona. The walls of the pulmonary cavity carry various chitinous processes. All the varied kinds of processes found on the plates or in the walls are analogous. The straight bars with free ends, which are borne by the pulmonary plates of *Epeira diademata*, appear in the embryo in the form of protuberances of the cuticle, and, in the course of development, become enormously elongated.

The two chitinous lamellæ which form a pulmonary plate are, in both Spiders and Scorpions, united by cells; these cells are separated by large spaces, in which blood circulates, and they reach, more or less, to the surface of the cuticle. These interlamellar cells are capable of contraction, and their alternate contraction and dilatation results in the movement of the blood which is contained in the lamellæ. The movements of the cells may also allow of the entrance and exit of a small quantity of air into the lung, but they are insufficient to account for the ventilation of the organ, which is due to other and as yet unknown causes.

The author regards the pulmonary plates of Arachnida as similar to the branchial plates of various Crustacea, and especially of the Pœcilopoda.

Embryology of Pycnogonida.‡—Mr. T. H. Morgan thinks that the evidence afforded by the developmental history of the Pycnogonida points to their affinities with the Arachnida. The process of multipolar delamination to form the endoderm seems to be common to the two groups; it is represented in its greatest simplicity in the majority of the Pycnogonida, while *Pallene* furnishes an analogy to the changes which an accumulation of food-yolk will cause in this process, and renders a comparison with the Arachnida quite possible. Other common points are the formation of an opaque area (*Pallene*) at the place where the

* This was called *P. insignis* in a preliminary account published in the 'Victorian Naturalist' for April 1890 (*sic*).

† La Cellule, v. (1890) pp. 255–317 (3 pls.).

‡ John Hopkins Univ. Circ., ix. (1890) pp. 59–61.

stomodæal invagination appears, and the early formation of mesoderm at this point; the general mode of appearance of ganglia and appendages; the body-cavity of the appendages, and the early appearance of mesoderm; the formation of endodermal pouches into the appendages from the mid-gut, which pouches contain yolk in the embryo. The large "upper lip" of *Chelifer* suggests a homology with the proboscis of the Pycnogonida. As the first (chelate) appendages appear at the sides of the stomodæum, and subsequently move forwards, and are innervated from part of the supra-œsophageal ganglia, they may be closely compared with the same parts in Arachnida. In Pycnogonids the lumen of the invagination of the stomodæum is triangular in outline and Schimkewitsch describes a similar triangular invagination in Spiders. The absence of brain invaginations seems to be the only good objection brought by embryology against the hypothesis of the relationship of Pycnogonida to Arachnida.

ε. Crustacea.

Development of Homarus Americanus.*—Mr. F. H. Herrick has found considerable resemblance between the mode of development of the American lobster and of *Alpheus*, but in the earlier stages there are some interesting differences. The eggs of the lobster have an average diameter of about 1·6 mm., and are invariably of a deep olive-green colour. The period of hatching in the summer at Woods Holl is nearly one hundred days. The initial stages of segmentation were not observed. The typical yolk pyramid structure is not present, but the entire egg divides into a large number of subspherical segments of irregular size. There appears to be a continuous migration of protoplasm from the central to the peripheral parts of the egg. The gastrula-phase commences with a small patch of cells which makes its appearance on the side of the egg where the cells are thickest; a minute circular depression in it (which may be called the blastopore) marks the point where numerous cells at the surface pass into the yolk, and spread out on all sides. At the time of gastrulation, the great central yolk-mass is destitute of protoplasm, whereas in *Alpheus* there is a migration of cells from the surface into the yolk before gastrulation begins. Later on, the position of the blastopore is marked by a solid, deeply-staining core of cells from which the cells gradually thin out on all sides. The anterior side of this cell-mass, which the author calls the keel, is marked by the more crowded condition of the cell-nuclei; this forms the proper embryonic area.

The naupliar appendages appear nearly simultaneously in the embryonic area at a considerable distance in front of the keel; they are at first widely separated, but after a short interval the embryo undergoes a marked contraction. The optic discs are represented by a single tier of columnar cells. The anterior portion of the keel enters into the abdominal plate; the invagination of the stomodæum occurs at a point between the first and second pairs of antennæ. The labrum soon begins to grow down over the mouth, the proctodæum is established as an ingrowth of ectoblast on the surface of the thoracic-abdominal process

* John Hopkins Univ. Circ., ix. (1890) pp. 67–8.

and the thoracic-abdominal fold can soon be distinguished. The stomodæum is a tube which is bent forwards and flattened antero-posteriorly; its wall consists of a single layer of cells; it is surrounded by degenerating nuclei, yolk, and cells derived either from the abdominal plate or from the epiblast. The appendages are chiefly filled with yolk which is not absorbed until a comparatively late period.

The spores form a marked characteristic of the early stages of the lobster, and throw light on similar bodies which have been observed in *Alpheus* and other Crustacea. They are small, deeply-staining masses of chromatin, and correspond to the granules or nucleoli of ordinary embryonic cells. It seems that we have here to do primarily with a remarkable case of cell-degeneration. The cells go to pieces, for some unknown reason, and the chromatin particles are gradually degraded into a substance resembling yolk. It is possible that these dissolving cells act as yolk-digesters. The spores disappear at a later stage, when five to six pairs of appendages are formed. The heart is represented by a space between the proximal end of the hind-gut and the body-wall; this is filled with plasma, blood-corpuscles, and mesoderm cells, derived from the thoracic-abdominal process.

In embryos of this stage there is a conspicuous circular patch of cells behind the heart, which probably represents one of the structures described under the name of "dorsal organ." The endoblast appears as a definite layer when eight to ten pairs of appendages are present; its cells are derived from the yolk, and thus we see that it is not till a later stage that the germinal layers are established. In the egg-nauplius we can only recognize an ectoblast and an internal layer which consists of yolk-cells, proliferated ectoblast, and cells derived from the abdominal plate and mesoblast. The keel probably represents the endodermal disc of the Crayfish. The structure and development of the nervous system, fore and hind guts, and various organs seem, so far as they have been studied, to agree essentially with those of *Alpheus*.

Developmental History of Brachyura.*—Mr. J. Lebedinski had for the chief object of his investigations *Eriphya spinifrons;* the female of this crab carries a large number of eggs attached to the hairs of its abdominal appendages. The egg is about 0·5 mm. in diameter, and is quite spherical. It is invested by a chorion and a vitelline membrane. The earliest stage observed was that in which the already developed blastoderm covered only one pole; at this stage some of the blastodermal cells unite to form a thick cylindrical epithelial germinal disc which gives rise to all three layers. The disc sinks down and exerts a mechanical compression on the underlying mesoendoderm; this latter takes on a regular arrangement, for just below the cylindrical epithelium there is a row of elongated cells, internally to which there are amœboid cells scattered in the yolk. The proliferating cells give rise to the ectoderm, the elongated to the mesoderm, and the amœboid, which multiply actively, to the endoderm.

While these processes are going on two new thickenings of the blastoderm are formed in front of, and independently of the disc; these, which have a bilaterally symmetrical arrangement, are the cephalic

* Biol. Centralbl., x. (1890) pp. 178–85.

lobes, from which the eyes and brain are, later on, formed. These lobes converge in the direction of the ventral median line, touch, and give rise to a considerable thickening, which is the rudiment of the labrum. The lobes and the disc together give rise to a germinal stripe, which corresponds to the ventral side of the embryo. The changes in the germinal disc are next described, and this is followed by an account of the changes in the cephalic lobes, and the formation of the nervous system.

In the Nauplius-stage the egg is completely invested by the continuous blastodermal layer. The rudiment of the eye is now separated on either side from the optic ganglion, and later on constricts off from the ectoderm a complex of ectodermal cells, which gives rise to the median elements of the eye. The ganglionic rudiments cease to be solid cell-aggregates, for each becomes hollowed as the ganglion-cells and dotted substance begin to be differentiated. This dotted substance appears to be the result of a direct conversion of some of the true ganglion-cells. The ganglion-cell elongates, becomes spindle-shaped, and finally breaks up into separate fibrils. Though the three pairs of appendages characteristic of the Nauplius-stage are somewhat developed, they are not yet jointed. The divisions of the digestive tract become apparent. The abdomen appears as an elongated process, which runs parallel to the ventral surface; the rectum is continued into it in the form of a cylindrical tubule, the blind end of which extends into the mass of amœboid cells, which are here arranged in two rows. The mesodermal cells become connected with those which have been given off from the germinal disc and the lateral ectodermal thickenings, and give rise to two mesodermal bands on either side of the median line. These bands become metamerically jointed, and, later on, give rise to the body-cavity, splanchnopleure, and somatopleure.

The rudiment of the heart appears in the form of a rounded solid mass of mesodermal cells, and lies between the thorax and abdomen; its cells have a coarsely granular protoplasm, and stain very strongly with borax-carmine. Later on, the peripheral cells elongate and form a unilaminate membrane, when the heart appears as a completely closed cavity. In its interior there are a few mesodermal cells, and some blood-corpuscles. It now begins to beat, but the regular rhythmical contractions are seen only in the inner mesodermal membrane, while the outer ectodermal wall, which has no muscular elements, plays only a passive part. Later on the mesodermal cardiac membrane is further differentiated, and in the zoea-stage the heart has the form of an elongated spindle-shaped tubule, the wall of which is everywhere delicate.

The first rudiments of the segmental organs are found in embryos shortly before the zoea-stage; they appear as a paired evagination of the somatopleure. They are ventral in position. The elongated lens-like cells of the somatopleure in their neighbourhood become cubical and cylindrical. Each cell of the evaginated wall has in its outer part a nucleus and some protoplasm, while the rest is free of protoplasm and highly cuticularized. The distal end of the evagination passes into a blind tubule, which elongates and soon forms a canal which, after several coils, ends blindly beneath the skin. Here the ectoderm becomes invaginated and forms a short tubule, the blind end of which

unites with the blind end of the canal. The resemblance between these organs and the segmental organs of Annelids, the organ of Bojanus in the Mollusca, and the pronephros of Selachians is sufficiently striking.

The author's observations concluded at the zoea-stage.

Stenorhynchus longirostris.*—Mr. D. Robertson has an interesting note on this common Crustacean. He has had occasion to doubt its carnivorous habits, and he has often seen it picking about its limbs (particularly the second pair, which are generally most invested with sea-weed), and conveying the produce to its mouth. "If other observations confirm the view that this animal is a true vegetarian, we shall have one example at least of an independent agriculturist who is not only superior of his lands, but carries them with him when he removes."

The Stalk of Barnacles.†—M. R. Koehler devotes the first part of his memoir on the structure of Cirripedia to a description of the stalk of Lepadidæ. While there is no doubt that the Cyprid larva fixes itself by its antennæ, there is some divergence as to the morphology of the stalk. For, according to Darwin, Claus, Willemoes-Suhm, and others, it is due to an elongation of the frontal region of the larva, while, according to Lang, it arises from an enormous increase of the anterior part of the cutaneous fold which lines the internal surface of the bivalve Cyprid carapace, the posterior part of the same fold forming the future mantle. This view is corroborated by the histological homology between stalk and mantle. The stalk consists of an external epithelium covered by a chitinous cuticle, of three layers of unstriped, peculiarly ramifying, muscle fibres (oblique, transverse, and longitudinal), and of a central mass of connective tissue, which is prolonged between the muscle-fibres on to the epithelium. This connective tissue in the proximal region of the stalk incloses the ovaries and cement-glands, while in the distal region, where it is less developed in consequence of the extension of the muscle-fibres, it only incloses the ducts of the cementing (possibly excretory) organs. Along its length the stalk exhibits a canal of large calibre, bordering on the rostral surface, and lying in a kind of gutter, which corresponds to a depression of the longitudinal layer of muscles. This canal branches towards its distal end, and opens at the other extremity into the general cavity of the barnacle. The oviducts, when formed, lie along its internal margin, and accompany it till it enters the body. Furthermore, on the sides there lie two large nerves from the sub-œsophageal ganglion, but these leave the canal and branch to form three principal pairs within the longitudinal layer of muscles. All these structures are described and figured in detail.

Vermes.

α. Annelida.

Perichæta.‡—Mr. F. E. Beddard has published some observations upon a South American species of Perichæta, together with some notes on the genus. He discusses the proposed divisions, and suggests that

* Proc. and Trans. Nat. Hist. Soc. Glasgow, ii. (1890) pp. 218–9.
† Arch. de Biol., ix. (1889) pp. 313–402 (4 pls.).
‡ Proc. Zool. Soc. Lond., 1890, pp. 52–69 (2 pls.).

the name *Megascolex* be applied to such forms as have the line of setæ interrupted, and the clitellum occupying more than three segments, while *Perichæta* will apply to those in which the line of setæ is continuous, and the clitellum consists of three segments only. The following new genera are proposed for species already described: *Diporochæta*, *Anisochæta*, and *Hoplochæta*. With regard to the distribution of the setæ in Chætopods the evidence afforded by the Oligochæta favours the view that a continuous circle of setæ is the archaic condition. Notes are added on the nephridia, the spermathecæ, and the glycogenic organs, additions are made to our knowledge of *Perichæta biserialis*, while *P. forbesi*, from New Guinea, and *P. vaillanti*, from Manila, are described as new.

Segmental Organs of Hirudineæ.*—M. H. Bolsius gives an account of the segmental organs of the Leeches. In all, the cavities of these organs, with the exception of the vesicle at the lower end, are intracellular cavities. In *Hirudo* and *Aulastomum* the organs consist of a glandular and of a collecting part; the former contains a network of anastomosing canals, and these canals receive the chief trunks of a system of intracellular vessels, which groove the cytoplasm of most of the cells. The network itself communicates with the collecting canal by an apparently small number of branches. This collecting canal, which is formed of perforated cells placed end to end, does not extend as far as the superior part of the gland which abuts on the testicle. It opens below into a urinary bladder which is lined by epithelium. This vesicle has a sphincter; its orifice pierces a cell—"the cellule-porte"—which forms the boundary between the intercellular and epithelial system of the bladder, and the intracellular system of the segmental organ.

In *Nephelis* and *Clepsine* the segmental organ has the form of a ribbon made up of a single chain of cells. This chain is perforated by three canals of unequal length; they arise in the cytoplasm of certain cells by a system of branching analogous to that of *Hirudo* and *Aulastomum*. The three canals appear to unite, and the single canal opens, as in *Hirudo*, by an orifice in a single cell. The urinary bladder is greatly reduced, especially in *Clepsine*; this bladder has no sphincter.

In the structure of the cells, attention may be drawn to the nuclei, which contain an abundance of caryoplasm, much reticulated; they contain a nuclear nucleolus which often possesses a distinct membrane, when it may be known as a "nucleole-noyau." In *Clepsine* the nuclei are often morula-like, and bear prolongations which are often cylindrical. The membranes of the cells and nuclei are dotted, as is also the wall of the internal canaliculi; the trabeculæ of the cytoplasm are inserted into these membranes in such a way as to establish an intimate relation between the canals and the reticulum. The trabeculæ of the cytoplasmic reticulum do not start from the nucleus as their principal centre, but from all the canals and internal canaliculi. In some of the canals there is a striated plate on the inner surface.

The cells are very intimately connected with one another. In the glands of *Hirudo* and *Aulastomum* they communicate by the system of

* La Cellule, v. (1890) pp. 369-436 (3 pls.).

anastomosing canals. At the level of their surfaces of contact, one does not, ordinarily, perceive two membranes, but one very delicate lamella, which perhaps represents a primary membrane. However, in old individuals, and above all in the case of *Aulastomum*, a complete fusion appears to be established, and this is particularly the case with the cells which form the collecting canals and the adjacent glandular cells. Similar relations are to be found in the segmental ribbon of *Nephelis*. In *Clepsine* there is a peculiarity in the mode of union of the segmental cells, for it is effected by very delicate prolongations of adjacent cells. In most cases the prolongations are equal in number to the canals of the region, and each gives passage to a single canal.

Body-cavity Liquid of Sipunculus Gouldii.*—Dr. E. A. Andrews reports that a specimen of this Gephyrean of average size contains about 1 ccm. of a saline liquid which contains a larger percentage of sodium chloride than sea water, and is rendered turbid and reddish by the presence of definite solids. There are red, white, and giant corpuscles, with spermatozoa in the male, and eggs in the female. The liquid clots quickly on removal from the body, and when washed, the clot resembles vertebrate fibrin in appearance and many reactions. The colouring matter of the red corpuscles is hæmerythrin, which is probably colourless when reduced, and seems to have iron associated with it. The presence of large amounts of proteid and saline material in the liquid is connected with its use as the only nutrient internal medium as well as the chief and ultimate respiratory liquid. The presence of iron perhaps indicates a genetic connection between hæmerythrin and the hæmoglobin of *Phoronis* and the Echiuridæ, while the other characters favour the separation of the Sipunculids from the rest of the Gephyrea.

New Phoronis.†—Dr. E. A. Andrews has a short note on a new, American species of *Phoronis*, which he calls *P. architecta*. It was found at Beaufort, N.C., inhabiting slender tubes which stand upright in rather impure or muddy sand. The tubes are isolated, and are formed by a clear, firm, chitin-like membrane, the upper part of which is covered with a layer of sand. The animal is about 50 mm. long and 1 mm. in its greatest diameter. There are about sixty tentacles which are arranged in a simple crescent. The lophophore is distinguished by the presence at either end of the crescentic bar of a large spoon-shaped organ which opens by a wide longitudinal slit into the extra-branchial or anal space; the cavities of the organs are ciliated and lined by a peculiar glandular epithelium. At the base of each there is a spherical "sense-lobe" which appears to correspond to the "glandular pit" described by Benham in *P. Kowalevskii*. The organ may be supposed to play a part in collecting or fixing sand-grains to the chitin-like tube. The longitudinal muscles are greatly developed, the sexes appear to be separate, and there is a ciliated groove in the digestive tract. In the first stomach intracellular digestion is effected by irregular ridges of epithelium rising up around one or more large diatoms and inclosing them within a syncytium-like mass.

* John Hopkins Univ. Circ., ix. (1890) p. 65.
† Ann. and Mag. Nat. Hist., v. (1890) pp. 445–9 (3 figs.).

β. Nemathelminthes.

Lemnisci of Nematodes.*—Dr. O. Hamann has come to the conclusion that there is a complete homology between a whole series of organs in Nematoda and Acanthocephala. The lemnisci of the latter, the history of which is so obscure, are to be found in Nematodes, where they have been called cephalic or cervical glands. These so-called glands are, in *Dochmius duodenalis* and all Nematodes which possess them, continuations of the dorsal and ventral longitudinal lines, just as the lemnisci of *Echinorhynchus* are continuations of the skin. The history of their development has shown that the subcuticula of Nematodes with its four outgrowths (so-called lateral or longitudinal lines) represents the epidermis, and is formed from the cellular ectoderm of the larva. The water-vascular system of *Echinorhynchus* is homologous with that of Nematodes. In both groups it lies in the skin (ectoderm), and has two longitudinal vessels, which, in the Nematodes, run in the dorsal and ventral longitudinal lines. There are also in the epidermis of Nematodes afferent canals of very various kinds, as well as structures which call to mind the lacunæ in the skin of *Echinorhynchus*.

The gigantic spherical nucleus, nearly 0·1 mm. in size, found in the lemnisci of Nematodes, is seen in *Echinorhynchus clavæceps*, and somewhat modified in *E. clavula*, *E. tænioides*, *E. spira*, and others. In both groups the lemnisci arise as projections from the epidermis into the body-cavity; they grow backwards and become finger-like and saccular organs, which in the simplest case merely contain a cavity or sort of canal. The lemnisci are, then, direct continuations of the skin, and there is no question as to the absence of an orifice. Not only can the ectodermal vascular system be shown to be homologous in the two groups, but the same is true of the body-cavity. In both there is a true cœlom lined by an epithelium. The polyhedral cells of this layer may, in either group, give rise to muscular fibrils, but in most members of both groups the epithelium disappears. On the whole, there is good reason for supposing that the Acanthocephala, of which *Echinorhynchus* is the representative, are not to be separated from the Nematodes.

New Nematode from a Galago.†—Prof. P. J. Van Beneden gives a description of a new Nematode, which he calls *Strongylus otolicni*, found in the cæcum of *Otolicnus peali*. It is about 15 mm. long, and 0·75 mm. thick; males and females were found in about equal numbers, and the latter do not appear to be viviparous.

Development of Strongylus strigosus and S. retortæformis.‡—Prof. A. Railliet has made some experiments on rabbits which prove that these two nematoids follow Leuckart's law, and develope without any intermediate host. The former is found in the stomach, the latter in the stomach also, but chiefly in the small intestine.

* Zool. Anzeig. xiii. (1890) pp. 210–2.
† Bull. Acad. Roy. de Belgique, lx. (1890) pp. 389–93 (1 pl.).
‡ Bull. Soc. Zool. France, xiv. (1889) pp. 375–7.

γ. Platyhelminthes.

Helminthological Studies.—Prof. M. Stossich describes the numerous species which make up the genus *Trichosoma* * Rudolphi. Thirty-one forms with a smooth, unarmed penial cirrus are distinguished as Gymnothecæ from sixteen Echinothecæ in which the same structure bears spines or bristles, while one form (*Trichosoma crassicauda*, *Trichodes crassicauda* according to Linstow) has no copulatory organ at all. Twenty-three species insufficiently defined bring up the total to seventy-one. Of these, twenty-three were found in mammals, thirty-nine in birds, three in reptiles, and the same number in amphibians and in fishes.

In a seventh report on Tergestine helminthology,† Stossich notices over a score of parasitic worms, and figures *Scolex polymorphus*, *Heterakis spumosa* and *fusiformis*, *Echinorhynchus lesiniformis* and *rubicundus*, and four species of *Distomum*.

In a third communication,‡ he catalogues fifty-six parasites from a collection made by Dr. A. P. Ninni, and briefly describes *Distomum crassiusculum*, *Tænia emberizorum*, and *Heterakis compar*.

The Skin of Ectoparasitic Trematodes.§—Herr M. Braun concludes from observations on *Polystomum integerrimum*, *Nitzschia* (*Tristomum*) *elongata*, and *Epibdella hippoglossi*, that the outer layer on the body of ectoparasitic Trematodes is a modified epithelium, which in certain conditions of altered function, e. g. in forming the hooks of *Polystomum* or the lateral suctorial pits of *Nitzschia*, retains its original epithelial character.

Anatomy of Amphiptyches urna.‖—Prof. W. Baldwin Spencer gives an account of the structure of this parasite. It was first observed by Wagener in *Chimæra monstrosa*, and Prof. Spencer has found it in the southern representative of that fish—*Callorhynchus antarcticus*. When alive it is of a creamy white colour, and the sides of the body and one end are crenate; this end the author, in opposition to Wagener, believes to be the anterior, and not the posterior. The opposite end of the body is characterized by a rosette of folds, and is pierced in the centre by a small tubular space which leads into the body; this space soon turns dorsalwards and opens to the exterior by a slight proboscis-like structure; the proboscis is capable of protrusion or retraction. It is difficult to assign any function to this curious structure, or to homologize it with anything present in other Cestodes, or, in fact, in other Vermes.

The most prominent feature of the body-wall is the presence of very distinct and numerous spines, which are generally distributed over the body-surface. The spines are somewhat elongate and are each composed of concentric layers of a transparent material. The epidermis consists of long, thin, columnar cells which pass internally into a layer of apparently homogeneous material; some of the cells are glandular, and they possibly secrete a sticky material which enables the parasite to adhere to the walls of the alimentary canal of its host.

* Boll. Soc. Adriat. Sci. Nat., xii. (1890) pp. 3–38.
† T. c., pp. 39–47 (1 pl.). ‡ T. c., pp. 49–56.
§ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 594–7.
‖ Trans. Roy. Soc. Victoria, i. (1890) pp. 138–51 (3 pls.).

The nervous system consists of a pair of strongly developed longitudinal cords, which extend on either side of the body from one end to the other. They give off branches on either side. No nerve-cells can with certainty be detected. The excretory organs consist of a network of tubes, the larger of which contain cilia. Each vessel is lined by a clearly outlined membrane-like layer which, in appearance, more resembles a fine cuticular structure than anything else. From one side a tuft of cilia projects into the lumen. In longitudinal section these cilia are seen to form a continuous line along one side of the vessels, and are apparently connected at their bases with cells, the nuclei of which can be detected. There are no structures to be found resembling the "flame-cells" of other Cestodes or of Trematodes, and another point of distinction is to be found in the position of the vessels which are for the most part placed in, and not superficial to the central core of connective tissue. After long search the author found, what Wagener failed to see, the external openings of the excretory system; they are on the ventral surface, one on either side of the body, and slightly in front of the external opening of the uterus. It is possible that there is more than a single pair of orifices.

Amphiptyches is hermaphrodite, and only one set of organs is present. It is doubtful whether it is self-fertilizing, as with the single exception of *Caryophyllæus*, it alone among Cestodes possesses a definite receptaculum seminis, a structure characteristic of not-self-fertilizing hermaphrodite animals. Wagener regarded this receptaculum as the testis. The real testes are a series of somewhat globular saclike structures which are scattered about irregularly in the posterior part of the body. Fine ducts, very difficult to distinguish, and probably only fully developed when the spermatozoa are actually in the act of transit to the exterior, pass from the testes into a common duct on each side, which again opens into a coiled tubular organ; this last is to be regarded as a vesicula seminalis. The tube into which it opens is probably eversible.

The coiled tubular uterus is the most prominent structure in the body. The ovary consists of a series of somewhat small grapelike ovaries, whence ducts pass into a central somewhat saccular organ filled with ova, which appears to hold the same relationship to the ovaries as the vesicula seminalis does to the testes. Each little ovary, when the ova are not fully formed, has the structure of a multinuclear mass of protoplasm which only subsequently becomes divided into a number of distinct cells. The yolk-glands consist of innumerable dark brown small spherical masses; they are distributed plentifully along the sides of the body. There do not appear to be any definite shell-glands.

Larvæ of Bothriocephalus in the Salmon.*—Dr. F. Zschokke describes five larval forms of *Bothriocephalus* sp. from the salmon of the Rhine. These seemed referable to several different species, but not in any case to *B. latus*. Two infection experiments with two different larval forms yielded no result. The larvæ are by no means frequent in Rhine salmon, for only three fishes out of ninety-three examined con-

* Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 393–6, 435–9 (5 figs.).

tained the parasites in question, while among seventeen salmon from the Baltic, four were infected. As to *B. latus* the author has found its larvæ in *Trutta lacustris*, perch, and pike.

δ. Incertæ Sedis.

Indian Rotifers.*—Mr. H. H. Anderson gives a first account of the species of Rotifers he has been able to find in the Calcutta tanks, and enumerates forty-seven, several of which are new. He looks, however, on this list as a mere instalment, for the weedy tanks teem with Rotifers. *Floscularia unilobata*, *Œchistes* [*sic*] *stephanion*, which differs from most of its congeners in having a very small corona, *Rotifer mento*, which seems to inhabit a tube, *Actinurus ovatus*, which does not possess all the generic characters ascribed to *Actinurus* by Dr. Hudson and Mr. Gosse, *Stephanops dichthaspis*, *Metopidia torquata*, *M. angulata*, *Pterodina intermedia*, *Brachionus longipes* and *B. bidentata* are the new species. Of the last but one, we are told that the foot is of extraordinary length, for in a dead specimen in which the lorica measured 1/100″, the foot, which was wrinkled, measured 1/75″; in living specimens the foot is often extended so as to be three times as long as the lorica.

Three new Rotifers.†—Mr. A. Pell states that, during the past winter, he found seventy species of Rotifers, sixty-four of which he was able to identify with forms described by Dr. Hudson and Mr. Gosse; three he was uncertain about, and three appear to be undescribed. *Mastigocerca bicuspes* is easily distinguished by the two spines on the back, one on each side of the median line of the body; it resembles *M. carinata*, but the ridge continues almost to the foot. The body is 1/200″ long, and the height of the body and ridge 1/300″. *Cathypna Stokesii* is easily distinguished by the two flattened points which terminate the lorica; it is not so broadly ovate as *C. luna*, and it has spines which are a continuation of the dorsal plate. It is 1/144″ long. *Copeus americanus* has a general resemblance to *C. labiatus*, but is distinguished from it by the absence of the large lip; it is more slender than that species, and it is 1/50″ in length.

Echinodermata.

British Deep-sea Echinoderms.‡—Prof. F. Jeffrey Bell has a note on some Echinoderms collected in deep water off the S.W. coast of Ireland, supplementary to his report already published.§ The most noticeable fact in this collection is the extension of the depths at which some of the more common shallow-water species—such as *Asterias rubens*, *A. glacialis*, *Stichaster roseus*, and *Spatangus purpureus*—were found.

Cœlenterata.

Actinida of North Sea.‖—The latest of the beautifully illustrated reports on the Zoology of the Norwegian North Sea Expedition is one

* Journ. Asiat. Soc. Bengal, lviii. (1889) pp. 345–58 (3 pls.).
† Microscope, x. (1890) pp. 143–5 (3 figs.).
‡ Journ. Marine Biol. Assoc., i. (1890) pp. 324–6. § *Ante*, p. 44.
‖ 'Den Norske Nordhavs Expedition,' 1876–8, xix. (Zoologi) 1890, 184 pp., 25 pls., 1 map.

by Dr. D. C. Danielssen, on the Actinida. All those which were collected came from deep water, and mostly from the cold area. As the author was a member of the expedition, he was able to keep these animals alive and sketch them with tentacles expanded and in characteristic attitudes. While following the classification proposed by R. Hertwig, which is chiefly based on anatomical characters, Dr. Danielssen has also made use of external points.

The forms described are thus arranged:—

Tribe Hexactiniæ, Fam. Amphianthidæ; *Korenia margaritacea* g. et sp. n.: Fam. Paractidæ; *Kadosactis rosea* g. et sp. n., *Kyathactis hyalina* g. et sp. n.: Fam. Sideractidæ; *Sideractis glacialis* g. et sp. n.: Fam. Sagartidæ; *Stelidiactis Mopseæ* g. et sp. n., *S. tubulariæ* sp. n., *Allantactis parasitica* g. et sp. n., *Anthosactis Jan Mayeni* g. et sp. n., *Sagartia repens* sp. n., *S. abyssicola* K. & D., *S. splendens* sp. n., *Calliactis Krøyeri* sp. n.: Fam. Bunodidæ; *Bunodes abyssorum* sp. n., *Actinauge nodosa* Fabr.: Fam. Tealidæ; *Tealiopsis polaris* and *Kylindrosactis elegans* gg. et spp. nn.: Fam. Madonactidæ; *Madonactis lofotensis* g. et sp. n.: Fam. Phelliidæ; *Phellia flexibilis, Ph. margaritacea, Ph. arctica, Ph. crassa, Ph. bathybia, Ph. norvegia, Ph. violacea, Ph. spitsbergensis* spp. nn., *Kodioides pedunculata* and *Cactosoma abyssorum* gg. et spp. nn.: Fam. Andvakiidæ; *Andvakia mirabilis* g. et. sp. n.: Fam. Halcampidæ; *Halcampoides abyssorum* g. et sp. n.

Tribe Edwardsiæ, Fam. Edwardsidæ; *Edwarsioides vitrea* g. et sp. n., *Edwardsia Andresi* sp. n.

Tribe Zoantheæ; Fam. Mardoellidæ; *Mardoel Erdmanni* g. et sp. n.: Fam. Zoanthidæ; *Epizoanthns arborescens, E. glacialis, E. roseus* spp. nn.

Tribe Ceriantheæ; Fam. Cerianthidæ; *Cerianthus Vogti* sp. n.

Tribe Ægireæ; Fam. Ægiridæ; *Fenja mirabilis, Ægir frigidus* gg. et spp. nn.

This enumeration will give some idea of the wealth of new forms collected and described by Dr. Danielssen; of the last two "new genera" we gave some account when the preliminary notice regarding them was published.* The importance, however, of this possession of a cœlom is so great that we will transcribe the remarks which the author finally makes on this question:—

"If we make the cœlom the decisive feature, it is then evident that my two species must be removed from the ranks of the Cœlenterata, but where they should then be placed I can really not indicate. It may, however, be the case that too much stress has been laid on the so-called gastrovascular apparatus as a systematic feature in naming the whole of the animal group that Cuvier called Zoophytes, Cœlenterata. What is called gullet-tube in Actinida is possibly a rudimentary intestinal formation, and those at the sides of the adjoining chambers may perhaps be considered as a beginning formation of the cœlom. This is still more distinct in the Ctenophora, where the gullet-tube has not only the form of an intestine, but also the function of a real digestive canal, even though anus is wanting, and is placed in direct communication with the gastrovascular cavity. In any case there is, here, in reality, no great step to a complete separation between the intestine and the body-cavity. Probably, even in the group of the Actinida, it may be

* This Journal, 1889, p. 230.

possible to show a different development of gullet-tube, and, in connection with it, a more or less complete separation of the so-called gastrovascular cavity; thus leading the relation in the genera *Ægir* and *Fenja* to be regarded as the final stage of a process that has already begun in other Actinida. But certain knowledge in respect of those relations will scarcely be obtained except by investigations of embryons, as then it will be seen whether they develope themselves as genuine Cœlenterata, or whether they possibly show themselves to belong to either Pseudocœlia or Enterocœlia. In the meantime I am satisfied with their assignment to the great division Actinida, but have, however, found it necessary to form a new race (tribus) for them."

The family Sideractidæ contains Actiniaria with numerous perfect septa; there are a few series of short non-retractile tentacles, the innermost of which contains eight mesodermal circular muscles; *Sideractis* in some respects approaches Gosse's genus *Bolocera*. *Atlantactis* has been placed with the Sagartiidæ, though it does not possess acontia, which R. Hertwig, though not Andres and others, regards as distinctive of the family; the same is true of *Anthosactis*.

The Madionactidæ are defined as Hexactiniæ with few principal septa, acontia, and a prominent endodermal circular muscular system. *Kodioides* has a pyriform body, with a long bare stem which terminates in a pedal disc; suckers are developed on the encrusted portion of the body. *Cactosoma* has a claviform body with an encrusted covering, the uppermost part being bare; the surface of the body is furnished with suckers. The Andvakiidæ are Hexactiniæ, elongated, set loose in the sand, without any real pedal disc, and the greater part of the body encrusted; the uppermost bare part of the body, the oral disc, and the tentacles are completely retractile; the septa are few. *Andvakia* is, in many points, a transitional form; in its internal structure it has several points in common with the Sagartiidæ and Phelliidæ, while in the external it differs considerably; in these last it seems to approach *Edwardsia*, its body being divisible into three parts.

The Mardoellidæ are Zoanthidæ which form colonies which, by means of a common rounded basal part, live freely in or upon the sand. *Mardoel* is allied to, and is perhaps identical with, a generic type characterized recently by Dr. Erdmann, but not named by him.

Special notice must be taken of the beautiful plates which adorn as well as illustrate this important memoir.

The Position of Sympodium coralloides.*—Prof. G. v. Koch describes *Sympodium coralloides* Pallas as a genuine Alcyonid, which by adaptation to a special substratum (Gorgonid axes) has acquired an apparent approximation to the Cornulariidæ. As an accurate comparison shows, it is really in close agreement and alliance with *Alcyonium palmatum* Pallas, and the author proposes to rename it *Alcyonium coralloides*.

Marginal Sense-organs in Pelagiidæ.†—Mr. R. P. Bigelow has a preliminary notice on this subject. He finds in the adult *Pelagia cyanella* a well-marked dorsal sensory groove, but no trace of the paired

* Zool. Jahrb., v. (1890) pp. 76-92 (10 figs.).
† John Hopkins Univ. Circ., ix. (1890) pp. 65-7.

folds of ectoderm in the sensory notch, while in the *Pelagia*-stage of the *Chrysaora* the rudiments of the folds have appeared, and in this species and *Dactylometra quinquecaria* the dorsal groove does not appear until the second set of tentacles begins to form. The *Chrysaora*-stage in the *Dactylometra* has the paired folds more developed than in the beginning of the adult stage in the *Chrysaora*, and different from what they are in the fully-formed adult of that species. Of the adult sense-organs in the three species, those of *Dactylometra* are the most highly developed. It appears, then, that in *Pelagia*, *Chrysaora*, and *Dactylometra*, there is, with increased complexity of general characters, an increase, both phylogenetically and ontogenetically, in complexity of the sense-organs; but the steps in the ontogeny of these organs are not strictly identical with the condition at the corresponding points in the phylogeny of the species.

Portuguese Man-of-War.*—Mr. R. P. Bigelow has had the opportunity of making some observations on the physiology of *Caravella maxima* Haeckel—the Portuguese Man-of-war. This Medusa feeds almost entirely on small fish, which are caught by running against its tentacles. The tentacle is immediately firmly attached to the fish, probably by the nettle-cells, and it is very soon temporarily paralysed by the poison from them. Before, however, the fish succumbs it manages to give a pretty vigorous pull on the tentacle. This acts as a stimulus to cause the tentacle to contract, the impulse apparently coming from the base. If the fish offers no resistance the tentacle does not contract. By the contraction of the tentacles the fish is brought into contact with the mouths of some of the siphons, the feeding members. These mouths are spread out over the fish until they completely envelope it. It is there finally killed and digested. The products of digestion with indigested fragments are taken into the stomachs of the siphons until they are gorged; digestion is completed in the stomachs, and the nutrient fluid is conveyed by the hollow pedicels to the rest of the corm. A siphon will attach itself with equal alacrity to a piece of fish or to a small stone, but does not remain attached to the latter very long.

The beating of wind or rain against the float causes its muscles to contract, so as to erect the crest, which normally lies flat on the water. It seems to require a good deal of effort to keep the crest erect.

The secretions observed were a mucous secretion on the surface, a gluey substance at the mouth, a digestive fluid, a poison in the nettle-cells, and, probably, the gas in the float.

The nervous system seems to be very poorly developed. There is some indication of a motor centre at the base of each tentacle, and impulses may be transmitted from one part to another. No correlation of movement was seen. There are no traces of any sense of sight, hearing, or smell; and it is doubtful whether there are any special senses.

Tetraplatia volitans.†—In the fourth of his memoirs on the lower animals of the Bay of Algiers, Dr. C. Viguier treats of this rare and interesting Cœlenterate. So far as is known it is pelagic, but it is

* John Hopkins Univ. Circ., ix. (1890) pp. 61–2.
† Arch. de Zool. Expér. et Gén., viii. (1890) pp. 101–42 (3 pls.).

possible that the pelagic and free state are but phases in the course of its existence. Its form is best understood by speaking of it as a regular octohedron, formed of two elongated pyramids with square base, and all the angles rounded. When alive, however, the creature is so contractile in every direction that it presents the most varied forms.

The supporting lamella which separates the endoderm from the ectoderm has been pretty satisfactorily described by Claus; the author gives his own account of the parts of which it is composed. For the greater part of the body the ectoderm consists of a single layer of thick cells with very short cilia; they have no muscular processes connected with them, and it is to their own contractility that we must ascribe the contractility of the body. Among the large ectodermal cells are the glandular cells and the cnidoblasts. The former are easily divisible into two parts—the true cell with its nucleus, and the gland, which is quite peripheral and has a very small excretory orifice. Claus did not distinguish the glandular cells from the vibratile cells which cover them. Some of the cnidoblasts are small and almost spherical; others, two and a half or three times as large, are still more spherical than oval. The former are found all over the surface of the body, while the larger are limited to a few placed on the median lines of the surfaces of the aboral pyramid, and are found in large number on the longitudinal ridges. After a lengthened description on the action of stinging cells, the author passes to an account of the sense-organs, on which various authors have expressed their opinions, but the mode of action of these bodies still remains a matter for conjecture.

While venturing to criticize some of Claus' expressions, the author can only "imitate his wise reserve as to the definite position which *Tetraplatia* ought to occupy in our classifications."

Histology of Hydra.*—Herr K. C. Schneider has investigated the histology of *Hydra fusca* with special reference to the nervous system of Hydropolyps. In the ectoderm we may distinguish epithelial and sub-epithelial cells according to their position; the epithelio-muscular and stinging cells are epithelial; the former are divided into investing and secreting cells, while the latter are only a modification of the former. The investing cells possess a cuticle, the peculiar property of which is indicated by the fact that the very delicate alternate with thicker areas; stinging cells are deposited in them, and they multiply by indirect division. The secreting cells give off granules which are arranged in parallel cords on the protoplasm; they contain no stinging cells, and their mode of multiplication has not been observed. All the muscle-cells give off basally long contractile fibres which are invested by protoplasm for their whole length; the direction of the fibres is longitudinal, but they seem to be somewhat sunk into the supporting lamella, into which they send processes. The stinging cells only reach the surface by means of the cnidocils which traverse the cuticle of the covering cells. Centrally they contain a stinging capsule, around which in most (and perhaps all) cases there is a muscular layer; this often, especially in the tentacles, passes into a muscular tubular stalk, within

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 321–79.

which are the nucleus and protoplasm. The stalk is connected with the supporting lamella.

The subepithelial tissue consists of ganglionic, sexual, and indifferent cells, the last of which give rise to the others and to the stinging cells. The ganglionic cells have a small nucleus, but no nucleolus, a small quantity only of protoplasm and long branching processes, which become varicose on treatment with acetic acid. These processes become connected with one another, with the epithelio-muscular cells, and probably also with the stinging cells. The spermatozoa have a cylindrical head, a transversely flattened middle piece, and a long, thin flagellum. The indifferent cells are rounded, cubical, or somewhat cylindrical, and have a nucleus of medium size, together with a nucleolus.

The stinging cells are derived from the indifferent by the central secretion of an alkaline product which is first surrounded by the inner wall, and by the outer only when the formation of the filament ceases. The filament is probably formed by the surrounding protoplasm growing into the secretion-cavity. The ganglionic cells are formed from the indifferent by the using up of the central part of the cell at the expense of the peripheral, which takes on a semilunar form and grows out into processes. The spermatozoa are formed by repeated indirect division of the indifferent cells.

The endoderm is likewise formed of epithelial and sub-epithelial cells. The former are epithelio-muscular, or nutrient, glandular, and sensory cells; in some of the first there are stinging-capsules. The epithelio-muscular cells have two (rarely three or one) flagella. They excrete basally a contractile fibre, which takes a circular course, and is less well developed than in the ectoderm. The processes into the supporting lamella are also more delicate. In the interior there are nutrient bodies, and brownish or reddish pigment; they multiply by indirect division. The glandular cells have two or three flagella; are shortly oval, and are rarely provided with a prolongation at their basal end; they have in their interior a highly refractive secretion which fills the protoplasm in the form of rounded balls. The sensory cells are filamentar, but somewhat thickened peripherally; they have an elongated nucleus and a short hair on the surface; at their base they break up into varicose processes; they would appear to be derived from epithelio-muscular cells. The stinging capsules appear to have no nucleus, and we cannot, therefore, suppose that they are directly derived from the nutrient cells. The ganglionic cells agree exactly with those in the ectoderm. They are derived from the sensory cells, as intermediate stages between them may be observed. The indifferent cells are like those of the ectoderm, but are much rarer.

The supporting lamella is a homogeneous intermediate layer between the ectoderm and endoderm, but is much more closely connected with the former.

In an appendix Herr Schneider deals with some of the histological elements of *Eudendrium ramosum* and *Tubularia larynx.* Their ganglionic cells correspond in form and position almost exactly with those of *Hydra fusca,* but the number of processes is smaller and the processes themselves are finer; the nucleus has a nucleolus; the processes of the cells were not observed to be connected with one another or with epithelial cells. The

stinging cells have a muscular investment, to which is attached a pretty long, thin, solid stalk which passes to the supporting lamella.

Heliotropism in Hydroids *—Dr. H. Driesch has observed heliotropic phenomena in the growth of *Sertularella polyzonias.* The stolons produced in unfavourable conditions instead of persons, are at first positively, and after the production of daughter-stolons, negatively heliotropic. They arise on the side of the mother-stolon turned towards the light.

Porifera.

Pseudogastrula Stage in Development of Calcareous Sponges.†—Mr. A. Dendy has had an opportunity of studying the development of *Grantia labyrinthica;* while within the maternal tissues the embryo lies in a cavity; as the embryo increases in size the capsule in which it lies becomes correspondingly enlarged; the side of the capsule next to the adjoining layer of spicules becomes flattened, while the opposite side bulges out into the flagellated chamber and forms a kind of blister over which the delicate wall of the chamber becomes tightly stretched. The embryo obviously receives nutriment from the mother sponge, probably through the medium of the endothelial cells. The granular cells of the embryo absorb nutriment from the maternal tissues, increase in size, proliferate rapidly, become invaginated mechanically, and when they have done absorbing nutriment become arranged in a hemispherical mass of large ovoid cells, highly charged with food-granules and an investing epithelial layer. The embryo is now ready to lead an independent existence, and the internal mass of granular cells seems to be a supply of food which enables it to wander for a long distance before becoming fixed. By degrees this food is absorbed and used up, and then the invagination of the ciliated cells takes place and the embryo becomes attached. It is for this reason that in the gastrula stage the internal granular mass of cells is no longer visible. This mass does not seem to have anything to do with the formation of mesoderm.

Anatomy of Hircinia, a new Genus of Sponges.‡—M. H. Fol brings forward some evidence to show that those authors have been in error who have regarded the fibrils of *Hircinia* as the work of an unknown parasite; these fibrils are, on the contrary, an integral part of the sponge. The family Filiferæ ought, therefore, to be re-established, as it is the most certain and best characterized of all the proposed divisions of Horny Sponges.

The name of *Sarcomus Georgi* is given to a large blackish sponge which is found in abundance near Nice, and is about the size of a man's head. A short description is given of it from which it appears that it is intermediate between *Spongelia* and *Aplysina*, which it resembles by the characters of its skeleton, and *Hircinia* and *Euspongia*, which it approaches in the disposition of its canalicular system.

Key to the Nomenclature of Sponge Spicules.§—Dr. R. von Lendenfeld calls attention to a "nomenclator spiculorum" prepared by Prof.

* Zool. Jahrb., v. (1890) pp. 147–56 (3 figs.).
† Proc. Roy. Soc. Victoria, 1890, pp. 93–101 (1 pl.).
‡ Comptes Rendus, cx. (1890) pp. 1209–11.
§ Biol. Centralbl., x. (1890) pp. 131–5.

F. E. Schulze and himself; it is, of course, impossible to abstract the contents of such a key, which, in the present state of confusion, cannot but be of value.

Protozoa.

Notes on Infusoria.*—Herr R. v. Erlanger gives accounts of a few Infusoria. *Actinobolus radians* Stein is the first dealt with; when swimming it has a pyriform shape, the thicker end being the hinder; this is contrary to Entz's statement. When at rest the form is often spherical; as the change in form is effected very slowly, the author supposes that there is no myoneme present; this again is contrary to Entz's view. The characteristic tentacles are arranged by twelves in the ciliated grooves, where they are separated from one another by regular distances. In swimming, the tentacles are retracted, while when the animal is quite still they are longer than the axis of the spherical body. When a tentacle is highly magnified three parts may be made out in it. The proximal part is thick, and conical in form, the next part is longer and half as thick, and both are transparent; the distal third is shorter, highly refractive and thinner; at its end is a capitulum which is much smaller than the terminal knob of the tentacles of the Acineta. There is a terminal trichocyst which completely distinguishes the tentacle of *Actinobolus* from that of the Suctoria. Since the discovery of this organism by Stein no other observer than Entz has given an account of it. Herr Erlanger gives a full account of it. *Chlamydodon mnemosyne* Stein, which the author found at Deauville, is next carefully described; it, again, has been noticed by but few observers. *Phascolodon vorticella* Stein is little known; it has a very peculiar form, the anterior end being broad and rounded, and forming an obtuse angle on the left side; posteriorly the animal becomes gradually smaller and ends in a blunt caudal tip; on the right and left of the ventral surface there is a longitudinally directed elevation; the median part is also convex, though not so high as the ridges. There are twelve longitudinal rows of cilia, the arrangement of which is fully described, as are other parts of the creature. *Hastatella radians* g. et sp. n. is a free-swimming Vorticellid, characterized by two parallel circlets of spines; these spines are simple outgrowths of the protoplasm of the body which are pretty thick at their base, and taper gradually. After describing its organization, the author compares the characters of this new genus with those of some other Vorticellids; in some points it resembles *Gerda* and *Astylozoon*, in others *Epistylis umbellaria* and *Vorticella microstoma*, and in others, possibly, *Cyclochæta*.

Structure of Distephanus (Dictyocha) speculum.†—Herr A. Borgert comes to the conclusion that the Dictyochidæ are independent organisms, and that, consequently, their tests are not—as R. Hertwig and Haeckel suppose—the isolated skeletal parts of Phœodaria. Haeckel's Dictyochidæ are primitively a skeletal species of Phœodaria. The Dictyochidæ must be separated from the Radiolaria, and be placed with the Mastigophora.

The protoplasmic body of *Distephanus speculum* consists of a small rounded soft structure which fills the cavity of the siliceous test, but

* Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 649–62 (1 pl.).
† Zool. Anzeig., xiii. (1890) pp. 227–31.

does not send out fine pseudopodia; in the place of these there is a long delicate, hyaline flagellum, by means of which the organism is capable of effecting lively swimming movements. The brownish-yellow colour by which living examples of *D. speculum* are distinguished, is due to numerous small rounded bodies which fill the protoplasm of the body; after the death of the organism these become of a greenish hue, in consequence of chemical decomposition; but it could not be satisfactorily determined whether one has to do with small symbiotic algar cells or with endogenous chromatophores. The nucleus, which lies in the middle of the body, is ellipsoidal and vesicular, and is surrounded by a delicate membrane; it consists of a vacuolated cortical layer and a central chromatin-body, and has, consequently, a certain resemblance to the central capsule of a very small Radiolarian.

The Dictyochidæ are, however, sharply separated off from the Radiolaria by the complete absence of pseudopodia, and by the possession of a flagellum. The appearance, also, of double individuals is a point of importance, as conjugation has never yet been observed in the Radiolaria, while it is very common among the Flagellata. The possession of a siliceous skeleton is an important point of distinction, and it is necessary to make a special order of the Mastigophora for the Dictyochidæ; this may be appropriately called the Silicoflagellata.

Colouring-Matter of the Peridinieæ.*—Dr. F. Schütt finds in the chromatophores of the Peridinieæ three distinct pigments, viz.:—

(1) *Phycopyrrin*; obtained as a dark reddish-brown fluid by crushing the Peridinieæ in a very small quantity of distilled water. The spectrum is nearly related to that of chlorophyll; it exhibits the strong absorption-band I, as well as, with a certain concentration, the band II; the end-absorption begins in the green. Phycopyrrin is readily soluble in alcohol, ether, carbon bisulphide, and benzol; the solution in the last three solvents is yellow, but has essentially the same spectrum as the aqueous solution. Its chief distinction from chlorophyll is in its solubility in water; its chemical properties seem to indicate that it is a connecting link between this substance and the phycoerythrin of the Florideæ; it is quite distinct from the diatomin of diatoms. In addition to this α-phycopyrrin, the author describes a β-phycopyrrin, differing from it in unimportant particulars, and probably a derivative from it.

(2) *Peridinin;* obtained by digesting for a short time in alcohol the Peridinieæ which have already been extracted with water; a wine-red solution is thus obtained, presenting a very different spectrum from that of chlorophyll; the band I is but faintly indicated, while a moderately sharp band appears between λ 64 and 63. Peridinin is readily soluble in alcohol, ether, chloroform, benzol, carbon bisulphide, and glacial acetic acid; it appears to represent in the Peridinieæ the xanthophyllin of flowering plants.

(3) A substance was further obtained identical with, or very nearly related to, the chlorophyll of plants.

Foraminifera of Faroe Channel.†—Mr. F. G. Pearcey gives a revised list of the Foraminifera found in the Faroe Channel. He dis-

* Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 9–32 (2 pls.).
† Proc. and Trans. Nat. Hist. Soc. Glasgow, ii. (1890) pp. 163–79 (1 pl.).

tinguishes these from the "warm-area" from those from the "cold-area," and gives a note of the quantity of each species that is found. In all, 228 species and varieties are recognized, 180 of which are found in the warm and 120 in the cold area. A description is appended of *Hyperammina palmiformis* sp. n., which is most interesting on account of its arborescent distal extremity.

Foraminifera of Older Tertiary of Australia.*—Mr. W. Howchin reports that the Muddy Creek beds contain one of the richest local faunæ known, either recent or fossil; no one locality in the British area of the rich Suffolk Crag has yielded more than 62 species, while the lower bed at Muddy Creek has yielded 163, and the Upper Bed 76 species. There is a close resemblance in the number of species noted by Mr. Brady from the remarkably rich dredging made by the 'Challenger' in Torres Straits and that of Muddy Creek, while many of the rarer forms are common to both.

* Trans. Proc. and Rep. Roy. Soc. South Australia, xii. (1889) pp. 1–20 (1 pl.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

α. Anatomy.

(1) Cell-structure and Protoplasm.

Structure of Living Protoplasm and Cell-membrane.*—Herr V. Fayod asserts that all living protoplasm is composed of delicate usually spirally twisted hollow threads, or "spirofibrillæ," composed of a hyaline unstainable somewhat toughly gelatinous substance, which easily swells up, generally coiled together in such a way that they themselves form the walls of spirally-twisted hollow cylinders, the "spirosparts." The cavities of both threads and cylinders are normally filled up by the so-called granular protoplasm, in which the streamings of protoplasm take place. The spirofibrillæ and spirosparts are the true morphological and physiological units, not limited to one cell, but passing from one to another, and traversing the whole plant.

These bodies are invisible in ordinary fluids, such as water, glycerin, Canada balsam in turpentine, oils, &c., in consequence of the great capacity for swelling of their walls; but their cavities can be injected with mercury under a pressure of two atmospheres; they may then be examined in longitudinal section in a 0·75–5·0 per cent. solution of sodium chloride, or in a mixture of equal parts of water and a saturated alcoholic solution of lead acetate.

Nature of Reserve-cellulose and its absorption in germination.†—Herr R. Reiss has investigated the nature of the so-called "reserve-cellulose" in the endosperm and other parts of the seed of a number of plants, and its mode of absorption on germination, and finds that it differs in most cases from true cellulose in its optical properties. The hydrolytic decomposition of ordinary cellulose gives a dextrose belonging to the group of grape-sugars, which reduces Fehling's solution, and to which the author gives the name *seminose*. The reserve-cellulose, on the other hand, consists of a substance which, on hydrolytic decomposition, yields a sinistrose carbohydrate, which is possibly a compound, and which the author calls *seminin*; it cannot, therefore, be identical with ordinary cellulose. The thickening layers, which are composed of this substance, are completely absorbed during the germination of the seed in six different ways, which are described in detail.

Non-nitrogenous Reserve-substances in the Seeds of Leguminosæ.‡—Referring to the observations of Nadelmann,§ but conducting his researches in a macroscopic instead of a microscopic method, Herr E. Schulze confirms his statement that one constituent of the thickenings of the walls of the cells of the cotyledons in *Lupinus* acts as a reserve-material; but this substance is, he states, not cellulose, but paragalactan.

* Naturwiss. Rundschau, v. (1890) pp. 81–4. See Bot. Centralbl., xli. (1890) p. 359.
† Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 322–9.
‡ T. c., pp. 355–9.
§ Cf. this Journal, 1889, p. 773.

In the seeds of the same plant were found also two other non-nitrogenous reserve-substances, viz. β-galactan and a fatty oil.

Cellulose-formation and Growth of Protoplasm without a Nucleus.*—In opposition to the statement of Klebs,† Herr E. Palla finds that the formation of cellulose and growth in length are not necessarily associated with the presence of a nucleus. Pollen-tubes, as those of *Leucojum vernum*, *Galanthus nivalis*, and other plants, the apices of which with their nuclei have been destroyed, still form a cap of cellulose round the protoplasm, or the protoplast breaks up into separate portions, each of which surrounds itself with a cell-wall. Protoplasm which has exuded may even sometimes clothe itself with a cell-wall and develope into a pollen-tube. Similar observations were made on leaves of *Elodea* and on root-hairs.

Intercellular Substance.‡—M. L. Mangin endeavours to show that in Phanerogams and Cryptogams (Fungi and many Algæ excepted) the tissues with soft elements are built up of cells united together by means of a cement formed of pectic acid in the state of insoluble pectates. The author calls this cement the intercellular substance, and its chemical nature may be shown in the following manner. Fragments of various organs (roots, leaves, flowers, &c.) must be allowed to macerate for twenty-four hours in alcohol, to which a fourth or fifth part of its bulk of hydrochloric acid has been added. The tissues are then washed and placed in an alkaline solution, and shortly, when the fragments of tissues have had time to become impregnated with the solvent, a slight agitation will dissociate them. If the liquid be now filtered and acid added, a gelatinous mass will be obtained which shows the characters of pectic acid. In order to examine tissues microscopically, thin sections of adult organs must be taken and coloured with phenosafranin or methylene-blue, after having been acted on by alcohol and hydrochloric acid. The insoluble pectic acid is coloured more strongly than the pectic compounds associated with the cellulose in the thickness of the membrane.

The author concludes by stating that intercellular substance formed of insoluble pectates is separated at an early period in merismatic tissues; its partial transformation into soluble pectates allows of lamellation of the cell-wall, and the formation of passages in adult tissues; by a sort of exudation, it forms bodies which strengthen the surface of union of the cells, and increase the solidity of the tissues.

Action of Oxidized Solution of Green Vitriol on living Cells.§—Herr T. Bokorny finds that a very dilute solution of iron sulphate (1 : 5000 to 1 : 10,000), when oxidized in the air, does not kill the protoplasm of *Spirogyra*. While turgor, the chlorophyll-band, and the nucleus remain unchanged, an excretion of granules (active albumin) takes place in the parietal protoplasm. From these facts he argues in favour of his previous conclusion as to the presence of hydrogen peroxide in the living cell.

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 330–1.
† Cf. this Journal, 1888, p. 758.
‡ Comptes Rendus, cx. (1890) pp. 295–7.
§ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 274–6.

(2) Other Cell-contents (including Secretions).

Chlorophyll in the Embryo.*—Mr. C. B. Atwell states that chlorophyll occurs in the embryo of *Tilia americana* and *Ipomœa purpurea*. In the latter species the chlorophyll appears as soon as the first traces of the cotyledons can be recognized in the cross-sections of the seed. It is abundant in the pod while the seeds are developing.

Colouring Matter of the Buds of the Horse-chestnut.†—Prof. L. Macchiati finds this to be an uncrystallizable substance resembling the phycoerythrin of Kützing and Cohn, but differing from that substance in being unaffected by light. It is soluble in water, but insoluble in alcohol, benzin, chloroform, ether, and other solvents. When dissolved out by boiling water and evaporated, it has a dark cherry-red colour.

Colouring Matters in the Integument of Seeds.‡—M. L. Claudel states that the researches of M. Poisson have established that the seat of the colouring matter in the integument of the seed is very variable. It is nearly always a protecting layer in the integument, the walls of which become thickened, and often coloured. The author now describes the following variations:—

In Cruciferæ it is the third layer which becomes the protecting layer, while it is the fourth in *Cistus*, and the fifth in *Tilia*. In *Phlox Drummondii*, *Gentiana germanica*, and *Scabiosa arvensis*, it is the superficial tissue that becomes coloured. Finally, it may be said that spermodermic colouring matters are formed only in living cells. There are a certain number of seeds in which the localization of colouring matter does not take place in the protecting layer (e.g. *Acanthus mollis*).

Colouring Matter of Grapes.§—M. E. Laurent finds in fruits two distinct layers of colouring substances, one of which depends absolutely on light for its production, while the other does not. The composition of the red colouring matter of grapes corresponds nearly to the formula C_2H_2O. It may be derived from glucoses by a process of dehydratization which takes place in the fruit during the last period of its ripening.

Calcium-salts and Silica. ||—In a very important and exhaustive work, Dr. F. G. Kohl treats of the mode of occurrence of these substances in vegetable cells and tissues, and of their physiological significance.

Calcium oxalate occurs in five different forms—as monoclinic and quadratic crystals, as concretions (Drüsen), as sphærites, as raphides, and as crystalline sand. By a long series of experiments he arrived at conclusions (which our space prevents us from going into) of the conditions under which these various forms are assumed. The lime may, under certain conditions, become again separated from the oxalic acid and act as a carrier of carbohydrates; while the excreted calcium oxalate plays a not unimportant part in the mechanical strengthening of the tissues.

* Bot. Gazette, xv. (1890) p. 46.
† Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 76–8.
‡ Comptes Rendus, cx. (1890) pp. 298–300. Cf. this Journal, *ante*, p. 196.
§ CR. Soc. R. Bot. Belg., xxix. (1890) pp. 71–6.
|| 'Anat.-phys. Unters. d. Kalksalze u. Kieselsäure in d. Pflanze,' Marburg, 1889, xii. and 314 pp. and 8 pls. See Bot. Centralbl., xli. (1890) p. 69.

Cystoliths the author regards as reserve-structures for calcium carbonate, which may again serve for the transport of carbohydrates. Silica he finds, in opposition to earlier observations, to be excreted in young parts of plants in process of formation, as well as in the mature organs.

A detailed description is given of the structures known as "cover-cells" (Deckzellen) or "stegmata," which occur in the interior of the tissue in certain groups of plants, viz. in the Palmæ, the Scitamineæ (except Zingiberaceæ), and some families of Orchideæ; in the Pandanaceæ they are replaced by crystals of calcium oxalate. They are cells which contain within them a free mass of silica of varying form, and are always more or less in connection with the intercellular system. The author believes that they play an important part in promoting a current of air through the tissues, and also serve as temporary reservoirs for water. The main function of silica in plants is, however, one of mechanical strengthening.

(3) Structure of Tissues.

Morphology and Anatomy of the Axis.*—M. P. A. Dangeard adopts Gaudichaud's terminology of "phyton" for the leaf, which constitutes a distinct individual, and consists of two parts—a cauline portion or rachis and an appendicular portion. The root is an ordinary axis which has undergone metamorphosis by the loss of its leaves, and the centripetal development of its protoxylem, which shows a close analogy with the central cylinder of Vascular Cryptogams. These phenomena are then studied in detail in two special genera.

In *Pinguicula* there is, in all the species examined, a strongly differentiated endoderm in the stem; it frequently displays thickenings on its lateral wall, and sometimes punctations on its other walls; the cells of this layer often contain a violet sap. Where the foliar vascular bundle enters the stem it divides into two halves, each of which becomes a sympode, right and left; these sympodes form a network, the size and form of the meshes of which vary according to the phyllotaxis. These sympodes may vary in two different ways. In the root of *P. vulgaris* the woody bundles may join in the centre or on the sides, and form a closed woody cylinder.

In *Acanthophyllum* a woody genus of Caryophyllaceæ, in which the leaves are more or less transformed into spines, the wood displays a great complexity of structure, recalling that of certain species of *Bauhinia*. In one section the leaf shows all transitions from the spiny to the ordinary form, in the diminution of the stereome, the reduction of the median bundle, the disappearance of the dorsal and increase in number of the lateral bundles, and the development of wings and of palisade-parenchyme.

Comparative Structure of the Nodes and Internodes in the Stem of Dicotyledons.†—M. A. Prunet states that at the nodes the epidermal cells are frequently of larger dimensions, and an increase in the thickness of the cortical parenchyme may also be noticed, this being due rather to the enlargement of the cortical cells than to their multiplication in

* Le Botaniste, i. (1889) pp. 175–207 (2 pls.).
† Comptes Rendus, cx. (1890) pp. 592–5.

number. Generally the pericyclic fibres become less numerous at the nodes; at the same time their walls are thinner and their size increases. These modifications are especially noticeable in the neighbourhood of emergent bundles; but it is in the xylem of the fibrovascular bundles that the greatest change takes place. The vessels diminish in diameter and become more numerous; the medullary rays also become more numerous and larger. The pith also increases, but in a smaller ratio than the cortex.

Sap-periderm.*—By this term Herr J. Wiesner designates a tissue found in aerial, but more often on underground parts of plants. It is distinguished from ordinary periderm by both its cell-wall and its contents being in a living condition, serving as an absorption-tissue for the storing up of water. It is always the tissue from which the ordinary periderm is formed. In the tuber of the potato it occurs as a stratum, often from six to ten cells in thickness, between the dead periderm and the phellogen, already passed into a permanent condition, cell-division having ceased in it; but the cells contain remains of protoplasm, and frequently a nucleus. As long as the potato remains in the soil this sap-periderm only is formed; the dead periderm, the cells of which are empty, is produced subsequently as a result of desiccation. This tissue occurs also in young twigs of the maple and lime, and may persist through the winter, but soon becomes covered by ordinary dead periderm.

Change of Shape exhibited by turgescent pith in water.†—Miss Anna Bateson calls attention to the fact that when turgescent pith is placed in water it increases greatly in length, but we have no accurate knowledge of any changes occurring in the transverse dimensions. The general results of a series of experiments directed to this question fall into two classes:—(1) The case of the sunflower, elder, and rhubarb, in which transverse contraction of the pith is the final result; (2) *Impatiens Sultani*, in which no contraction occurs; transverse extensibility is here so great that transverse expansion is not only clearly apparent from the first, but is never overcome by longitudinal expansion, the pith continues to expand transversely, and never exhibits a subsequent contraction.

Passage from Stem to Root.‡—M. P. A. Dangeard has studied the phenomena presented by the tissue at the point of passage from stem to root in Dicotyledons. He finds a constant relationship between the type of venation in the cotyledons and the number of vascular bundles in the root—pinnati-veined cotyledons are associated with a root of the diarch type, palminerved cotyledons with a root of the tetrarch type. The phloëm-bundles behave in the same way as the xylem-bundles, but their fusion does not necessarily take place at the same level. The term "collar" should be reserved for the spot where the epiderm of the tigellum unites with the outer piliferous layer of the root. It is almost impossible to determine the exact level at which the union of the tissues of the two organs takes place. The author asserts that the pericycle of the stem is of a different nature from that of the root, belonging, in the former, not to the conjunctive tissue,

* Oesterr. Bot. Zeitschr., xl. (1890) pp. 107–11.
† Ann. of Bot., iv. (1889) pp. 117–25.
‡ Le Botaniste, i. (1889) pp. 75–123 (2 pls.).

but to that of the bundles, or, more exactly, to the phloëm-region of the bundles outside the group of sieve-elements. For the pericycle of the stem he proposes the term *periphragm*.

In Gymnosperms * the number of cotyledons may vary even within the same species. When the number of cotyledons is either two or three, then the number of fibrovascular bundles in the root corresponds to the number of cotyledons, the xylem-bundles alternating with the phloëm-bundles. But when the number of cotyledons is more than three the number of bundles in the root is only half that of the cotyledons.

Unlignified Elements in the Xylem.†—Dr. R. Raimann states that unlignified thin-walled cells frequently occur near the primary vessels in Dicotyledons. They have been observed in *Æsculus*, *Tilia*, *Aristolochia Sipho*, and *Fagus*. He proposes for these elements the term *interxylary cambiform*, since they resemble the cambiform in the soft bast in their origin, form, and structure. Their function he has at present been unable to determine.

The author further states that the formation of the innermost xylem-zone takes place at a later period than that of the outer zones which follow the protoxylem. The elements of the protoxylem do not form a closed tissue, but proceed either without any definite order or in radial rows out of the inner portion of the protoxylem. It is the elements of the innermost xylem-zone immediately surrounding the first vessels, or lying in rows between the rays of protoxylem, which remain for a time unlignified, forming the interxylary cambiform; and even if they subsequently become lignified, their walls remain thin and they retain their cambiform character.

Growth of the Cystoliths of Ficus elastica.‡—A careful examination of the structures has led Herr C. Giesenhagen to the following conclusions. The stalk of the cystoliths consists of cap-shaped lamellæ of uniform structure which also cover one another on the sides. Their body is composed of homogeneous nearly concentric lamellæ of cellulose, in and between which there is a deposition of calcium carbonate. The radial strings in the body are tubular cavities filled with lime. The stratification, both in the stalk and in the body, arises from the successive deposition of homogeneous lamellæ of cellulose formed from the cell-protoplasm. The lamellæ of cellulose in their body continue to increase considerably in size and density after their deposition, this depending nearly or exclusively on the subsequent importation of calcium carbonate. The calcium carbonate is believed by the author to be present, both in a state of combination with the cellulose and also free between the surfaces of contact. The growth of the cystoliths of *Ficus elastica* appears, therefore, to take place partly by apposition and partly by intercalation.

Recent observations in Anatomy.§—Dr. D. H. Scott gives a very useful *résumé* of the most important publications since the appearance of De Bary's 'Comparative Anatomy of Phanerogams and Ferns,' published in 1877, which have added to our knowledge of the anatomy of plants.

* Comptes Rendus, cx. (1890) pp. 253–4.
† SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 40–75 (2 pls.).
‡ Flora, lxxiii. (1890) pp. 1–30 (1 pl.). § Ann. of Bot., iv. (1890) pp. 147–61.

(4) Structure of Organs.

Structure of the Olive.*—Sig. A. Bottini gives a detailed description of the structure of the ripe drupe of the olive, distinguishing the characteristics of several Italian varieties. The minute warty excrescences found on the surface of the ripe fruit are lenticels, each of which was originally a stomate; the passage from one to the other can be readily followed by examining the fruit at different stages of development. The mesocarp consists of a spongy parenchyme, the cells of which have very thick walls; interspersed among these are sclerotized cells, with greatly thickened and hardened cell-walls, the proportion of which to the thin-walled tissue varies greatly in different varieties. The oil is found in the whole of the mesocarp except the lenticels and the sclerenchyme, almost filling up the cell-cavities. The pigment of the olive is dissolved in large quantities in the cell-sap.

White Bilberries.†—In opposition to the view of Woronin,‡ Herren P. Ascherson and P. Magnus maintain that the white variety of the bilberry, *Vaccinium Myrtillus* var. *leucocarpum*, is distinct from the diseased berry caused by the attacks of *Sclerotinia baccarum*, and that it is an example of the albinism which is not uncommon in fruits, as, for example, in the white currant.

Fruit of Aurantiaceæ.§—Sig. L. Savastano has determined that the splitting which is so common a phenomenon in the fruits of the Aurantiaceæ, especially in the orange, and in those of some other fruits, such as stone-fruits, the pear, fig, pomegranate, &c., is the result of the excessive absorption of water by the protoplasm, and of the small resistance offered by the cell-walls to compression from the tissue of the sarcocarp.

Seed of the Hemp.‖—Prof. L. Macchiati gives a minute description of the anatomical structure and the phenomena of germination of the seeds of *Cannabis sativa*. The points to which he calls special attention are the great inequality in the size of the two cotyledons, which becomes more conspicuous after germination, and the entire absence of starch from the embryo, the cells of which are filled with oily substances and grains of aleurone; the proteid crystalloids of these aleurone-grains are insoluble in cold water, but dissolve readily in water slightly acidulated.

Pitchers of Insectivorous Plants.¶—Referring to the observations of Dr. Macfarlane,** Prof. F. O. Bower adduces additional reasons for regarding the lid of the pitcher of *Nepenthes* as resulting from the coalescence of the only pair of pinnæ formed on the winged phyllopode; and for concluding that in *Sarracenia* the leaf is throughout a simple phyllopode, the lid being merely its flattened terminal portion, and the

* Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 369–81 (2 pls.).
† Ber. Deutsch. Bot. Gesell., vii. (1890) pp. 387–400 (1 fig.).
‡ Cf. this Journal, 1889, p. 263.
§ Boll. Soc. Nat. Napoli, iii. (1889) pp. 273–88.
‖ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 58–63.
¶ Ann. of Bot., iv. (1890) pp. 165–8 (3 figs.). ** Cf. this Journal, 1889, p. 779.

flap an outgrowth in a radial plane, somewhat similar to that of the leaf of *Iris* or the phyllode of *Acacia*. There is no evidence here of coalescence of pinnæ.

Modifications of Leaves in Maritime Plants.*—M. P. Lesage draws the following conclusions as the result of his investigations on this subject:—(1) Plants living near the sea have thicker leaves than those inland; but there are certain exceptions to this rule. (2) The palisade-cells are generally much developed and the lacunæ reduced in maritime plants. (3) Chlorophyll is generally less abundant in the cells of plants living near the sea. This conclusion is not quite so constant as the preceding. (4) The fleshiness of leaves, the development of the palisade cells, the reduction of the lacunæ, and the diminution of the chlorophyll, can be effected by experimental cultures where salt is the variable element.

Structure of the Margin of Leaves.†—Herr R. Hintz describes in great detail the various modes in which the leaves of plants are mechanically protected against tearing, whether by local mechanical thickening, or by the special arrangement of the marginal veins. These he classifies under three types, and the connection between these special structures and the arrangements for storing up water in the margins of the leaves are further detailed.

Fall of Hairs.‡—Herr W. Kärner describes the conditions favourable to the formation of hairs on leaves and other parts of plants, and the causes which lead to their subsequent disappearance. This latter may result from the amount of water in the cells, from changes of temperature or moisture in the air, from the formation of a coating of silica on the surface, from rain, wind, and other causes. The amount of water in the cell-wall also influences the durability, as well as the stiffness or brittleness of the hairs. The mechanical arrangements by which the hairs are detached are also described.

β. Physiology.

(1) Reproduction and Germination.

Pollination and Distribution of the Sexual Organs.§—Herr A. Schulz continues his researches on this subject, recording a very large number of observations on plants belonging to a great variety of natural orders. A few general remarks are appended.

In the family Sileneæ of Caryophyllaceæ, the proterandry is in many species so marked as to render self-fertilization impossible. Only two observed species, *Tunica prolifera* and *Vaccaria parviflora*, were homogamous. In the family Alsineæ, on the other hand, the proterandry is

* Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 55–65, 106–21, 163–75 (3 pls. and 1 fig.). Cf. this Journal, *ante*, p. 363.

† Nova Acta K. Leop.-Carol. Akad. Naturf., liv. (1889) pp. 97–214 (3 pls.). See Bot. Centralbl., xlii. (1890) p. 50.

‡ Nova Acta K. Leop.-Carol. Akad. Naturf., liv. See Bot. Centralbl., xli. (1890) p. 294.

§ Biblioth. Botan. (Luerssen u. Haenlein), Heft 17, 224 pp., 1890. Cf. this Journal, 1888, p. 612.

not nearly so decided. Female flowers occur in almost all the species except *Mœnchia erecta* and *Mœhringia trinervia.* In the Umbelliferæ, with only a few exceptions, male flowers occur in addition to the hermaphrodite, less often female flowers. The various forms are described in detail for *Euphrasia Odontites* and *E. officinalis*, and the long and short-styled forms of species of *Primula.* Lists are appended of those species in which unisexual flowers or individuals occur at different periods in the time of flowering; of species normally hermaphrodite, which occasionally produce unisexual flowers; of the insects which are in the habit of biting through the corolla to obtain the honey; and of the species of flower the corolla of which is pierced in this way.

Fertilization of Ficus Roxburghii.*—Dr. D. D. Cunningham describes the remarkable phenomena connected with the development of the fruit of this species of fig in Calcutta. The receptacles or inflorescences are male and female, and the species is diœcious. The male receptacles contain true male flowers which produce pollen, and modified or atrophied female or "gall-flowers," which never produce seed, but within the ovaries of which the eggs of an insect are deposited and undergo evolution. The female receptacles contain true female flowers, in which the eggs of insects are never found, and which produce fertile seeds. The ostiole or opening of both male and female receptacles is so obstructed by a covering of bracts, that the receptacles are almost closed chambers. But the perfect development of both male and female flowers is dependent on the access of the "fig-insect" to the interior of the cavity of the receptacle, without which neither of them attain functional condition. The insect most commonly found is a species of *Eupristis.*

Although the development of embryos in the female receptacle is essentially connected with the access of the insects to the receptacular cavity, yet Dr. Cunningham believes that it is independent of the introduction of pollen by their agency. The nearly entire closure of the ostiole by bracts presents an almost insuperable obstacle to the introduction into the female receptacles of a sufficient quantity of pollen for the impregnation of every one of the ovules in the exceedingly numerous female flowers by a separate pollen-grain; and but very few pollen-grains could be found within the female receptacles. Although it is possible that in some instances ordinary pollination may occur, yet the author asserts that the embryo is ordinarily formed independently of any such process, and arises as an outgrowth of the nucellar parenchyme outside the embryo-sac. Up to the period of insect-access, and of the initial development of the embryo, the embryo-sac retains its character of a simple uninucleate cell without oosphere, synergidæ, or antipodal cells. The full development of both male and female flowers appears to be dependent simply on hypertrophy of all the tissues of the receptacle resulting from stimulation caused by the access of the fig-insects. This stimulation is the result of the female insects laying their eggs within the ovary of the "gall-flowers" in the male receptacles, and of their persistent attempts to do the same within the flowers of the female

* 'On the Phenomena of Fertilization of *Ficus Roxburghii* Wall.,' Calcutta, 1889, fol., 37 pp. and 5 pls.

receptacles, although these attempts are here frustrated by the great strength and thickness of the ovary-wall.

Fertilization of Scrophulariaceæ.*—Prof. E. Warming describes the mode of fertilization in the Greenland species of Scrophulariaceæ, especially those belonging to the genera *Veronica*, *Pedicularis*, *Rhinanthus*, *Bartsia*, and *Euphrasia*. In *Pedicularis* we find every gradation between species with horizontal lower lip to the corolla, like *P. flammea*, adapted for self-fertilization, and species with oblique lower lip, like *P. lapponica*, adapted for cross-fertilization. All the Greenland and Iceland species of *Euphrasia* are self-fertilized.

Fertilization of the Grape-vine.†—Dr. M. Kronfeld states that, although the cultivated grape-vine is usually anemophilous, yet that, under certain conditions, it is fertilized by honey-bees, especially when there is in the same neighbourhood an abundance of other plants which are visited by bees.

Trimorphism of Scabiosa succisa.‡—Mr. A. Turner points out the existence of three distinct forms of this common British plant, viz.:—(1) hermaphrodite; (2) and (3) two different female forms, differing from one another remarkably in the size of the capitula and of the flowers, the arrangement of the flowers on the receptacle, the colour of the corolla, and the presence or absence upon it of stellate hairs, and especially in one having a perfectly straight and the other a much bent style. He further describes the mode in which this trimorphism assists in crossing by insects.

Pollination of Eryngium and Cakile.§—Herr P. Kunth describes the mode of pollination of *Eryngium maritimum* and *Cakile maritima*. Both are habitually cross-fertilized, though the latter may also be self-fertilized. The former is strongly proterandrous, and is effectively protected against the visits of intruding insects by its spiny foliage and involucre. The pollinating insects are Hymenoptera, Diptera, and Lepidoptera, and to a large extent the same species in the case of both plants.

Fertilization of Phyllis.‖—Prof. F. Delpino describes the mode of pollination of *Phyllis Nobla*, endemic in the Canary Islands, belonging to the Rubiaceæ, which is strictly anemophilous. He proposes to limit the tribe Autospermeæ of the order to genera which are strictly anemophilous.

(2) Nutrition and Growth (including Movements of Fluids).

Parasitism of Thesium.¶—M. O. Lignier finds that the nature of the soil has no influence on the production of the vegetative organs of *Thesium divaricatum* var. *humifusum*, and that it is parasitic on a considerable number of species. It derives its nourishment from the host

* Bot. Tidsskr., xvii. (1889) p. 202.

† Ber. Deutsch. Bot. Gesell., vii. (1889) Gen.-Versamml.-Heft, pp. 42–4. Cf. this Journal, *ante*, p. 208.

‡ Nature, xl. (1889) pp. 643–4.

§ Bot. Centralbl., xl. (1889) pp. 273–7 (5 figs.).

‖ Malpighia, iii. (1889) pp. 348–9.

¶ Bull. Soc. Linn. Normandie, iii. See Morot's Journ. de Bot., iv. (1890) Rev. Bibl., p. x.

by means of a number of haustorium-tubercles, of which the largest attain a diameter of 5 mm.; it attacks the stem, leaves, and root in the underground zone of the host, but not the root-tubercles of *Lotus* or *Medicago*.

Transpiration-current in Plants.*—Herr T. Bokorny finds the most convenient method of tracing the course of the ascending current in a plant to be by causing it to absorb small quantities of iron sulphate (not more than 0·1 per cent.), and then precipitating by potassium ferricyanide.

By this method he has determined that the elements through which the greater part of the conduction of water takes place are the vessels (and the tracheids of Conifers), a current being always perceptible in the cell-cavity; whether there is also any considerable conduction through the walls, he leaves undetermined. A current through the walls appears to take place in some cases, but not in others. The pith often gives strong lignin-reactions, and is therefore quite incapable of conducting water. The water also appears to rise through the prosenchymatous cells of the xylem, through those of the sclerenchyme, through the thin-walled bast, and through the collenchyme. The ascent through the sclerenchyme and collenchyme appears to tell against Sachs's imbibition-theory. In the upper portions of the stem of *Nicotiana* and *Cucurbita* the walls of the vessels alone were found to contain iron. In *N. rustica* the water had risen to the extent of 1 metre in three-quarters of an hour.

Passage of Gases through Plants.†—Prof. J. Wiesner and Dr. H. Molisch give the following as the chief results of a series of experiments on this subject.

Gases subject to pressure are unable to penetrate by filtration either through the cell-wall, whether living or dead, whether dry or saturated with water, or through the protoplasm or watery cell-sap. The movement of gases from cell to cell can take place only by diffusion when the tissue is a close one, or also through the intercellular spaces where these occur; the rapidity of diffusion is in proportion to the quantity of water imbibed by the cell-wall. Dialysis of dry air cannot take place to any determinable amount through cell-walls when they are neither lignified nor suberized; but it can take place through lignified or suberized cell-walls. Carbon dioxide diffuses through cell-walls more rapidly than hydrogen, oxygen, or nitrogen, the rapidity of diffusion being proportional to the absorption-coefficient and the density of the gas. Carbon dioxide passes out of vegetable cells by diffusion more rapidly into air than into water. Periderm is more hygroscopic, and imbibes water more rapidly, than had previously been supposed.

(3) Irritability.

Movements of Nutation.‡—Dr. A. Hansgirg distinguishes several kinds of nutation, especially in connection with petals and leaves, viz.:—

The ephemeral and periodical nutation-movements of petals, which

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 469–503.
† SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 670–713.
‡ Oesterr. Bot. Zeitschr., xl. (1890) pp. 48–53.

have for their object the protection of the sexual organs and of the honey, and the promotion or prevention of foreign pollination; these may be termed *gamotropic* movements, in contrast to the nyctitropic movements, which serve merely for protection from injurious radiation at night.

Movements of the bracts, sepals, and petals, and of the flower-stalks for the protection of the ripening fruit, or for the dissemination of the fruit or seeds—*carpotropic* movements.

The author gives also numerous instances of *photo-cleistogamic* flowers, in which the opening of the flower is prevented by the rapid growth of the outer side of the petals, the result of photo-hyponasty; of the nutation-movements of leaves and petals which are caused not only by changes in light and temperature, but also by variations in turgidity, and of such as are caused by variations in temperature and turgidity only; and of the movements of nutation and irritation in stamens, styles, and stigmas.

The leaves of *Marsilea* exhibit movements of irritation under the influence of concussion, in addition to the more conspicuous sleep-movements. The leaves of many Papilionaceæ exhibit more considerable paraheliotropic movements in southern than in northern latitudes, for the protection of their chlorophyll from intense sunlight.

Influence of Heat on the Movements of the Flowers of Anemone stellata.*—According to Herr H. Vöchting, the flower-stalk of this plant, which, before the unfolding of the flower, is bent downwards, becomes erect immediately on its opening, bending towards the sun, and following its course through the day; in the evening the plant takes up a sleep-position, the perianth closing, and the flower-stalk again bending downwards. A careful series of observations convinced the author that these successive movements were in no way due to changes either in the light or in the degree of moisture, but entirely to changes in temperature. Contrary to what takes place in *Papaver*, the movements of the flower-stalk of *Anemone stellata* are not directly dependent on the flower, since they continue even after this has been cut off.

(4) Chemical Changes (including Respiration and Fermentation).

Formation of Starch from Organic Substances by Leaves.†—As the result of a series of experiments with a number of different carbohydrates and other organic substances, Herr G. Nadson finds that the chlorophyllous cells of various plants (Dicotyledons, Monocotyledons, Vascular Cryptogams, and Algæ) can in nearly all cases form starch out of cane-sugar, dextrose, and dextrin, less uniformly out of milk-sugar, glycerin, mannite, and melamprite, never out of inulin, quercite, glycogen, gum-arabic, calcium saccharate, or out of tartrates, oxalates, or malates. As a general rule, starch can be formed out of substances which contain the two radicals of alcohol, CH_2OH and CHOH, but not out of those which contain only one of these elements.

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1889) pp. 285-97.
† Arb. Petersburg Naturf. Ver. 1889, 50 pp. See Bot. Centralbl., xlii. (1890) p. 48.

γ. General.

Special Characters of Plants at high altitudes.*—M. G. Bonnier finds that, when plants are cultivated in alpine regions—other conditions except those of climate remaining the same—the aerial stems become shorter and prostrate; the flowers more highly coloured; the leaves thicker and of a deeper green; the protecting tissues of the stem more strongly developed; and, in consequence of the greater development of the palisade-tissue and the abundance of chlorophyll, the assimilation in the leaves becomes more energetic in proportion to the surface.

Myrmecophilous Plants.†—Mr. W. Trelease describes the extra-floral nectaries for the entertainment of ants in *Calycanthus*, and for the colonies of Aphides in *Andromeda*. Ritter R. v. Wettstein ‡ gives a useful bibliography of the phenomenon of myrmecophilism.

Herr K. Schumann § treats generally of the structures for the accommodation of ants in stems, branches, and leaves; and describes in particular the bladders on the branches of *Duroia hirsuta*, the entrances into the tuberous stem of *Myrmecodia bullata*, the bladders on the under side of the leaves of *Tococa lancifolia*, and on the upper side of the leaves of *Duroia saccifera*, and Müller's bodies in *Cecropia*.

Nanism in the Vegetable Kingdom.‖—Dr. D. Clos discusses the conditions under which plants exhibit nanism, or the dwarfed condition,—its causes, whether internal or external, and the various modes in which it manifests itself.

Relationship between Snails and Plants.¶—Herr F. Ludwig describes the mode in which the gigantic leaves of *Petasites officinalis* and those of other plants are destroyed by snails, especially by *Succinea putris*, leaving nothing but a skeleton of vascular bundles. As previously described in the case of the hop, the snails appear to have a special liking for the patches of parasitic fungi, e. g. *Coleosporium Sonchi* and *Puccinia Poarum*, which frequently occur on the leaves.

Use of Micrography in Botany.**—M. P. Vuillemin discusses the use of micrographic characters in descriptive botany. He concludes that their employment may be recommended from three points of view, viz. (1) to determine incomplete plants, or plants altered in their form, and species of minute size; (2) to corroborate or to rectify classifications based on other characters; (3) for the determination of certain questions relating to the genetic relationship of plants, which are unapproachable by other modes of research.

* Comptes Rendus, cx. (1890) pp. 363–5.

† Psyche, 1889, pp. 171–80. See Biol. Centralbl., x. (1889) p. 44. Cf. this Journal, *ante*, p. 212.

‡ See t. c., p. 44. § See t. c., p. 45.

‖ Mem. Acad. Sci. Toulouse, 1889, pp. 375–406.

¶ SB. Gesell. Naturf. Freunde Berlin, 1889, p. 197. See Bot. Centralbl., xli. (1890) p. 295. Cf. this Journal, 1889, p. 548.

** Bull. Soc. Bot. France, xxxvi. (1889) Actes du Congrès de Bot., pp. xc–xcix.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Anatomy of Vascular Cryptogams.*—M. P. A. Dangeard classifies the very numerous species of *Selaginella* into two primary sections, dependent on the arrangement of the leaves,—*Homotropæ*, in which the leaves are of one kind only, and are opposite or arranged in various phyllotaxes, 3/8, 5/13, &c.; and *Dichotropæ*, in which they are of two kinds, and are arranged in four longitudinal rows. These are then divided into a number of groups, according to the structure of the stem and leaves.

In the stem of *Lycopodium* we find a collection of cauline bundles, corresponding in their origin and structure, and in their relationship with the leaves, with those of *Selaginella*; they are united into a central cylinder either by their metaphloëm only, or also by their metaxylem. *Tmesipteris* possesses a rhizome entirely destitute of leaves, which presents a transition to a true root. In the vascular bundles of the stem the metaxylem is not simply centripetal, it surrounds the protoxylem, which gradually disappears, leaving a lacuna.

In the stem of *Salvinia* the central cylinder is large; the endoderm has here and there a tangential septum; scattered through the central parenchyme are a few vessels, the largest of which are replaced by a lacuna; the phloëm is external, but passes insensibly into the central parenchyme which contains the vessels. In the Marsiliaceæ the fibrovascular system is more complicated, and the leaf attains a great development; the vascular bundles of the leaves are surrounded by an endoderm. The structure is very similar in the Filices.

In the Equisetaceæ we appear to have an approach to the structure of Phanerogams. In several species a lacuna makes its appearance on the internal face of the bundle, and this leads directly to the ordinary collateral bundles of the Dicotyledones.

Anatomy of Marattiaceæ.†—The following are given by Dr. R. Kühn as the more important results of a fresh examination of the anatomical structure of the stem of Marattiaceæ, the species examined being chiefly *Kaulfussia æsculifolia* and *Marattia fraxinea*.

Kaulfussia has a creeping dorsiventral stem, while that of *Marattia* is, when young, radiar and erect, passing over gradually into a fleshy tuberous stem. The vascular bundles of the stem and leaves of *Kaulfussia*, *Marattia*, and *Angiopteris* are really concentric, not bicollateral like those of leptosporangiate ferns, the phloem-portion surrounding the xylem-portion; there is no bundle-sheath. In the leaf-stalk of *Marattia fraxinea* is a peculiar joint which appears to serve as a motile organ, the sclerenchyme-fibres within it passing over into collenchyme. The mucilage-passages are of lysigenous origin, from the absorption of the cell-walls of adjacent cells; the mucilage itself originates from the disorganization of the protoplasm of these cells; there are no epithele-cells. The peculiar masses in the roots of Marattiaceæ are the result of an infection by a fungus, similar to that of the Orchideæ, and the

* Le Botaniste, i. (1889) pp. 211–70 (3 pls.).
† Flora, lxxii. (1889) pp. 457–504 (2 pls.), and lxxiii. (1890) pp. 147–50.

same is the case with the Ophioglossaceæ, and with *Lycopodium inundatum*.

The following particulars are added with regard to other classes of Vascular Cryptogams:—No mucilage is found in the Ophioglossaceæ, while, on the other hand, it is more widely diffused in the Lycopodiaceæ than has been supposed. *Osmunda regalis* and *Todea barbara* have, in connection with the vascular bundles of the leaf-stalk, cells which produce a mucilage containing tannin, and similar cells are found in many Cyatheaceæ. The vascular-bundle-cylinder in the cortex of the stem of *Struthiopteris germanica* belongs to the stem, and not to the leaf. The stem of *Botrychium* has a secondary growth in thickness, but limited to the new formation of a few tracheïdes.

Danæa alata corresponds with other Marattiaceæ in the anatomical structure of the stem (or root-stock) in all essential points. There are no sclerenchymatous elements, it contains mucilage-passages and tannin-cells, and the vascular bundles are concentric. It presents, however, a peculiarity in the root, in the presence, as in the leaf-stalk, of a closed ring of sclerenchymatous fibres, two or three rows of cells in thickness, a few layers below the epiderm.

Muscineæ.

Peristome.*—M. Philibert now describes the structure of the peristome in various genera of Splachnaceæ. In *Splachnum* the interior cells are thickened along the whole length of their walls, the adherence of the two peristomes is complete, and the internal membrane divides into sixteen segments. In the three other European genera of Splachnaceæ the ordinary diplolepideous type is found. The author then describes the peristome of *Splachnobryum Boivini*, a member of a genus composed entirely of exotic species. The teeth are composed of two membranes joined together by a complex mass of cells arranged in several rows in the upper part, the internal peristome only remaining; this is exactly the converse of what is found in *Dissodon*, *Tayloria*, and *Tetraplodon*, where the external peristome alone remains.

The author then proceeds to point out the differences between the Nematodonteæ and the Arthrodonteæ, and especially describes the Discelieæ and Leptostomeæ. The family of the Discelieæ, which consists of a single genus and single species *Discelium nudum*, does not differ greatly from *Funaria* in its aspect and vegetative system, the capsule and spores being analogous. The peristome is composed of sixteen regular teeth, in which the two layers can be easily distinguished. The curious family of Leptostomeæ differs from all other known genera in the peristome, which is reduced to a single uniform and undivided membrane, representing the primitive framework from which is derived the double peristome of the Arthrodonteæ. The author concludes by describing the peristome of *L. macrocarpum* and *L. inclinans*.

Fibres in Medullary cells of Sphagnum.†—M. F. Gravet records the presence of fibres in the medullary cells, or cells of the central zone of the stem, in a small number of specimens of the immersed form of *Sphagnum cuspidatum*, and also in a form of *S. recurvum*.

* Rev. Bryol., xvii. (1890) pp. 8–12, 25–9. Cf. this Journal, *ante*, p. 68.
† Rev. Bryol., xvii. (1890) p. 21.

Stem-leaves of Sphagnaceæ.*—Dr. J. Röll adduces a variety of examples to demonstrate his statement that the stem-leaves may vary considerably in the same species of *Sphagnum*, and that trustworthy specific characters cannot in all cases be drawn from them.

Algæ.

Algæ as a cause of the Impurity of Water.†—Mr. G. W. Rafter publishes the results of a series of observations on Freshwater Algæ, and their relation to the purity of public water supplies. He finds that a number of algæ (and Schizophyceæ) may contribute to render drinking water unpotable, producing a nauseous or "fishy" smell, generally due to the decomposition of their mucilaginous envelope, or of the starch or oil contained in their cells. In addition to the Schizomycete *Beggiatoa*, which has the property of withdrawing the sulphur from sulphates in solution, the following may be mentioned:—*Cladophora*, *Vaucheria*, *Batrachospermum*, *Draparnaldia*, *Chætophora*, *Volvox*, *Eudorina*, *Pandorina*, *Hydrodictyon*, *Palmella*, *Crenothrix*, *Oscillaria*, and the diatoms generally, especially *Meridion circulare*. The desmids appear mostly to be innocuous.

Inferior Algæ.‡—M. P. A. Dangeard dissents from Bütschli's classification § of the Eugleneæ, Cryptomonadineæ, Peridinieæ, Chlamydomonadineæ, and Volvocineæ with the Flagellata, considering them to be true Algæ, as is determined by their mode of life.

Among the special forms described is *Anisonema viridis* [*e*] sp. n., belonging to the Palmellaceæ, and nearly allied to *Palmella hyalina*. Among the Polyblepharideæ, *Pyramimonas tetrarhynchus* is described in detail, characterized by having four projecting lateral wings and four cilia. To the same family belong *Chloraster agilis* and *C. gyrans* with five cilia. Among the Chlamydomonadineæ a new genus and species *Corbieria vulgaris* is described, distinguished from all the other genera of the family by the posterior position of the nucleus and by the red-brown colour of the oosperm, which has also a double instead of a single membrane.

Among the Volvocineæ, *Pandorina* is stated to have a *Gonium*-like early stage, which rapidly changes into a sphere. In *Eudorina* he finds green as well as yellow antherozoids. Under the Tetrasporeæ, a new species and genus, *Schrammia barbata* is described, consisting of two- to eight-celled colonies inclosed in a cellulose-gelatine, rapidly becoming incrusted in calcareous water. The contents are blue-green, and it may belong to the Cyanophyceæ; it appears to be allied to *Glœochæte* Lagerh.

In the non-sexual Pleurococcaceæ we have a new genus and species *Hariotina reticulata*, apparently derived directly from the Volvocineæ, resembling a *Pandorina* in the act of division. It consists of a number of green spheres, each consisting of from four to sixteen spherical cells, irregularly united together into a network by stout threads. It multi-

* Bot. Centralbl., xli. (1890) pp. 241–5, 273–8.

† Trans. Amer. Soc. Civil Engineers, 1889, pp. 483–557 (9 pls.). Cf. this Journal, 1889, p. 677.

‡ Le Botaniste, i. (1889) pp. 127–74 (2 pls.). Cf. this Journal, 1889, p. 95.

§ Cf. this Journal, 1889, p. 776.

plies by repeated division. Another new genus and species belonging to the same family is *Placosphæra opaca*, consisting of spherical or somewhat elliptical cells 24 μ in diameter, with a thick calcareously incrusted membrane, a central pyrenoid, and lateral nucleus. It is reproduced by repeated division, and appears to be most nearly allied to *Nephrocytium*.

The author regards the Hydrodictyeæ as derived from the Volvocineæ, the colonies having lost their motility; under unfavourable vital conditions they may become encysted. *Polyedrium trigonum* Näg. is not a stage in the development of a *Pediastrum*, but is an independent organism; it breaks up, on germination, into new individuals. This genus and *Scenedesmus* may be considered as abnormal Hydrodictyeæ, in which the production of zoospores and sexual reproduction are suppressed.

Hybrid Desmid.*—Mr. A. W. Bennett describes a possible hybrid desmid between *Euastrum humerosum* and *E. crassum*.

Trentepohlia.†—M. E. de Wildeman recurs to several critical points in determination of the species of this genus, and dissents from its division into two classes by De Toni and Hansgirg, dependent on the colour and odour, characters which vary with the conditions of growth and of drying. Species, he states, which have been separated and placed in the two classes ought to be united. He proposes an alternative classification into two groups, the first with the cells cylindrical, or rarely irregularly elliptical, the second with the cells oval, elliptical, or irregular, never cylindrical. The species in both groups vary as to colour and odour.

M. P. Hariot ‡ gives a complete monograph of the genus, which he considers as nearly allied to *Cladophora*, differing in its terrestrial habit, its more or less bright coloration, and its mode of fructification. The family Trentepohliaceæ is divided by him into two groups, Cephaleuroideæ and Chroolepideæ, the latter being made up of the two genera *Trentepohlia* and *Nylandra*. He classifies the species of *Eu-trentepohlia* under two groups, the first with cylindrical cells (11 species), the second with torulose or moniliform cells (6 species). One new species is described. *T. Wainoi*. A second sub-genus, *Heterothallus*, intermediate between *Eu-trentepohlia* and the Phycopeltideæ, has the primary filaments ramifying in a single plane, and forming a circular horizontal rosette. It comprises three species, including *T. depressa*, hitherto included under *Cœnogonium*, and a new species, *T. Leprieurii*, from Cayenne.

The new genus *Nylandra*, comprising only a single species, *N. tentaculata*, is distinguished from *Trentepohlia* only by the cells of the thallus producing setiform appendages.

Movements of the Protoplasm in Caulerpa.§—Dr. J. M. Janse has investigated the nature of the energetic movements of protoplasm within

* Ann. of Bot., iv. (1889) pp. 171–2 (1 fig.).
† Bull. Soc. R. Bot. Belgique, xxviii. (1889), Pt. ii., pp. 67–70, 95–100, 125–7. Cf. this Journal, 1889, p. 420.
‡ Journ. de Bot. (Morot), iii. (1889) pp. 345–50, 366–75, 378–88, 393–405; iv. (1890) pp. 50–3, 85–92, 178–80, 192–7 (24 figs.).
§ Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1889) pp. 163–284 (3 pls. and 1 fig.).

the unicellular sac of *Caulerpa prolifera.* He finds that the phenomenon bears no relation whatever to that of rotation in the higher plants, such as the familiar examples in *Nitella* and *Hydrocharis*, and but little to that of circulation such as is seen in the hairs of *Tradescantia* and *Cucurbita.* The parietal protoplasm of the mature "leaves" contains an uninterrupted layer of chlorophyll-grains, in which no motion whatever could be detected. The motion is observed mainly in the strings of protoplasm which pass from one to another of the beams of cellulose which occur in such large numbers in the interior of the cell; these strings form a continuous mass of protoplasm with the protoplasmic layers which invest the cellulose-beams. The beams increase in number from the base towards the apex of the "leaf." The protoplasmic strings inclose chlorophyll-grains which are carried along in the current. Branches of these strings run into the prolifications.

No similar movement of the protoplasm, or only a very feeble one, was observed in *Valonia*, *Bryopsis*, or *Codium;* in *Acetabularia mediterranea* it was much more apparent.

Injury to the leaves of *Caulerpa* is speedily remedied, first by accumulation of the protoplasm which escapes from the wound, followed by copious formation of cellulose. The protoplasmic phenomena in the rhizome and in the rhizoid correspond, in general terms, with those in the leaf.

The familiar beams of cellulose are outgrowths from the inner side of the cell-wall. Their main function appears to be to preserve the form of the organ in which they are found under different degrees of turgidity; if they are cut through, the leaf increases very greatly in thickness. They also aid, through their protoplasmic envelope, in guiding the currents of protoplasm within the cell which serve for the transport of the food-materials.

Fungi.

Nucleus of Peronospora.* —Mr. H. W. T. Wager has investigated the structure of the nuclei in *Peronospora parasitica*, a common parasite on cruciferous plants, and their behaviour during the formation of the oosperm. The following is a summary of the results.

Mycele, antherids, oogones, and gonids (spores) contain numerous deeply-staining nuclei which exhibit a very clear nuclear structure. The division of the nucleus takes place by a process of karyokinesis similar to that which occurs in the higher plants. This can be most satisfactorily observed in the nuclei of the oogone. These are, at an early stage, spherical or slightly oval vesicular bodies, each of which contains a large mass of chromatin, forming a peripheral layer on its wall. All the nuclei of the oogone divide, and the process of division is accompanied by complicated changes in the protoplasm, leading to the formation of the oosphere. At an early stage the protoplasm of the oogone appears to be a homogeneous granular mass, containing numerous nuclei. A number of vacuoles appear in the centre of the oogone, and cause the greater part of the protoplasm to be restricted to the

* Ann. of Bot., iv. (1890) pp. 127–46 (1 pl.).

periphery. At the same time the nuclei swell up, and exhibit a thread-like structure; they assume a very regular arrangement, and form a single layer in the parietal protoplasm. The chromatic threads next arrange themselves in the equatorial plane of the nucleus, and then divide into two groups of threads, each of which forms a daughter-nucleus. The daughter-nuclei again divide, and then two, or perhaps more, pass towards the centre of the oogone, and soon afterwards the cell-wall of the oosphere begins to form on the inner side of the parietal layer of protoplasm, leaving this, together with the remainder of the nuclei outside, to form the periplasm. From this mass of protoplasm and nuclei both the endospore and the exospore are formed.

One or more antherids are developed in connection with the oogone. The antherids send out fertilizing-tubes, swollen at the ends, which pass to one side of the oosphere, come into close contact with it, and appear to open into it by a small aperture. The passage of a nucleus from the antherid into the oosphere has not been directly observed, but it is probable that fertilization does take place, as two nuclei have been seen in the oosphere at about the time when the nucleus or nuclei from the antherid appear to pass through the fertilizing-tube.

The nuclei of the mycele divide in a similar manner to those of the oogone, but they do not become so large, nor exhibit the details so clearly. The gonids or zoosporanges contain numerous nuclei, differing in structure from those in the other parts of the plant. They consist of a central mass of protoplasm, surrounded by a layer of nucleoplasm, with a firm outline. They are spherical or slightly oval bodies, a little larger than the nuclei of the mycele.

Smut of Wheat and Oats.*—Mr. J. C. Arthur states that *Ustilago fœtens* B. & C. (*Tilletia lævis* Kuhn) may be recognized by its strong fœtid odour, which is especially noticeable in the evening, or when the air is moist. If the spores of *U. fœtens* are placed under the Microscope, the black powder will be found to consist of an infinite number of round corpuscles, in the middle of which delicate ramifying filaments will be perceived, to which the spores are attached. The reproduction of this fungus is very simple. The spores forming the black powder are transformed, under certain conditions of temperature and humidity, into short branched tubes, and from these escape other minute spores.

Endothlaspis.†—Prof. N. Sorokine, in his description of the materials for a Cryptogamic flora of Central Asia, gives the diagnosis of a new genus of Ustilagineæ, *Endothlaspis*. The filaments of the mycele destroy the ovary of the host. On the surface of the pistil the filaments divide by transverse septa and form the tissue. Each cell of this tissue is transparent and colourless, and is provided with a nucleus. In the interior of this pseudo-periderm the filaments of the mycele change into a mass of black or blackish spores. The author describes and figures two species:—*E. Melicæ*, parasitic on the pistil of *Melica ciliata;* and *E. Sorghi*, parasitic on *Sorghum cernuum.*

* Bull. Agricult. Exper. Station, Indiana, Sept. 1889, 32 pp. See Rev. Mycol., xii. (1890) p. 90.

† Rev. Mycol., xii. (1890) p. 4.

"Pourridié" of the Vine.*—M. P. Viala has followed out the life-history of *Dematophora necatrix*, the cause of the disease of the vine known as *pourridié*, and the mycele of which constitutes various kinds of "rhizomorph." It produces its conidial form only on the organs of the vine which it has destroyed, and on which it carries on a saprophytic life. In addition, the author was able, by varying the method of culture, to produce the peritheces which had not previously been observed, and which are formed only on dry soil at least six months after the formation of the conids. The asci are filiform, and contain eight ascospores. M. Viala regards *Dematophora* as forming a distinct genus of Tuberaceæ, the first genus of the order in which the formation of conidiophores has been observed.

New Disease of Pine Trees.†—M. E. Mer has had his attention called to a large number of fir trees, in which the last four or five shoots of some of the branches had completely dried up or perished. This was due to the attacks of a fungus, the pycnids of which show considerable resemblance to those described and figured by Saccardo under the name of *Dothiorella pythia*. The author hopes to meet with spermogones or peritheces in a state of maturity in order to give a more exact determination and a complete description of the parasite.

Sphæropsideæ and Melanconieæ.‡—Herr A. Allescher describes a large number of fungi from South Germany belonging to these orders, including six new species belonging to the genus *Actinonema*, all found on the leaves of various trees and shrubs, usually in a fallen but still living condition; also two new species of *Pestalozzia*.

Podaxis.§—From an examination of specimens of *Podaxis indica*, from South Africa, Mr. G. Massee assigns this genus of Fungi to the Ascomycetes, removing it from the family Podaxineæ of Gastromycetes. It closely resembles in appearance a long-stalked puff-ball. The glebe is, however, destitute of the sinuous cavities and well-defined tramal plates characteristic of the Gastromycetes, presenting from its earliest appearance a sponge-like structure. The thin-walled colourless hyphæ which form the irregular walls of the glebe put out numerous long lateral branches, which are the ascogenous hyphæ. The asci are lateral outgrowths from these, at first papillæform, but afterwards cut off by a septum, and are densely crowded; each contains a single ascospore, or less often two, which escape from the ascus through a lateral slit. Some species (*P. Emerici*) appear also to produce basidiospores homologous with the normal asci. The different species further present a differentiation in the presence or absence of a capillitium.

The author regards the entire group of Gastromycetes as having sprung from the Tuberaceæ, one line of evolution having been through the genera *Elaphomyces*, *Podaxis*, and *Tulostoma*.

Nutrition of Oidium albicans.‖—MM. G. Linossier and G. Roux find that free oxygen is absolutely indispensable to the growth of this

* Comptes Rendus, cx. (1890) pp. 156–8.
† Bull. Soc. Bot. France, xxxvii. (1890) pp. 38–48.
‡ SB. Bot. Ver. München, March 10, 1890. See Bot. Centralbl., xlii. (1890) pp. 42 and 74.
§ Journ. of Bot., xxviii. (1890) pp. 33–9, 69–77 (2 pls.).
‖ Comptes Rendus, cx. (1890) pp. 355–8. Cf this Journal, *ante*, p. 220.

fungus; the more abundantly it is supplied with atmospheric air, the more luxuriantly it grows; when immersed, the growth is feeble in proportion to the depth below the surface. The rarity of the air appears to favour its filamentous form of development. Of food-materials the carbohydrates are those which are most favourable to its growth, and in proportion to their high molecular equivalent. Slightly alkaline media are more congenial than neutral or acid.

Lily-disease.*—Mr. A. L. Kean has investigated a disease which is exceedingly destructive in Bermuda to a variety of *Lilium longiflorum*, and finds it to be due to a species of *Botrytis* growing upon or within the leaves or flowers, in all probability identical with that described by Prof. Marshall Ward † as attacking *Lilium candidum* in this country.

Production of Varieties in the Saccharomycetes.‡—More than a year ago Dr. C. C. Hansen succeeded in rearing varieties of Saccharomycetes which since this time have been cultivated without interruption in beer-wort, also in other liquid nutritive media and on solid media, or, in other words, they have been cultivated under very different conditions, and, nevertheless, have not regained their original faculty of spore-formation. In beer-wort especially, innumerable generations have been produced every fourteen days, and frequently new cultivations have been oftener effected. The transformation which the cell-protoplasm has undergone has therefore been of a nature so profound that it has been transmitted from generation to generation, and there does not seem any likelihood that it will disappear as long as the cells are cultivated in wort. Hence, in general terms, the principal result of the author's experiments has been the production of varieties, the new characters of which are retained in the most diverse cultivations.

About the methods whereby he has effected these changes the author gives only general indications. These are that cultivations were made from a low yeast at a temperature just below that which prevents budding. The cultivation-medium was beer-wort. Although the cells had lost their power of developing spores, they were still actively reproductive, and capable of exciting alcoholic fermentation.

Action of Alcoholic Ferments on various kinds of Sugar.§—The examination, by Prof. E. C. Hansen, of the action of forty kinds of yeasts on saccharose, maltose, lactose, and dextrose, showed that, with the exception of the endosporous *S. membranifaciens*, all species of the genus *Saccharomyces* possess the power of forming invertin and exciting alcoholic fermentation in saccharose and dextrose. On the other hand, *S. marxianus*, *exiguus*, and *apiculatus*, like the Torulæ, were unable to ferment maltose, although this is decomposed by the rest of the Saccharomycetes, by *Monilia candida*, and the Mucor yeasts. *Monilia candida* is, moreover, the only yeast which decomposes saccharose directly without the previous formation of invertin. *Mucor erectus* excites fermentation in saccharose solution, but not in that of dextrose. Only a single alcoholic yeast, that discovered by Duclaux in 1887, fermented lactose.

* Bot. Gazette, xv. (1890) pp. 8–14 (1 pl.). † Cf. this Journal, 1889, p. 265.
‡ Annales de Micrographie, ii. (1890) pp. 214–21.
§ Op. c., i. (1888). See Bot. Centralbl., xxxix. (1889) p. 160.

The facts adduced by the author are of importance to the analytical chemist if he have to examine a mixture of several kinds of sugar.

Peridium and Spores of Uredineæ.*—Mr. H. J. Webber suggests that the size and form of the cells of the peridium, which he regards as being developed from æcidiospores, may be useful characters in determining the species of Uredineæ. He further describes peculiar spores in several species of Uredineæ. In *Puccinia flaccida* the teleutospores, though often one-celled, are also frequently two-celled, and the septum may then be in almost any position, from nearly horizontal to vertical; the author regards this species as more resembling a *Uromyces* than a *Puccinia*. In *P. Sporoboli* the teleutospores are one-, two-, or three-celled, the different forms occurring either in the same or in different sori. The teleutospores of *P. Tanaceti* are equally variable in structure. In *Uropyxis Petalostemonis* the author has also observed a three-celled teleutospore.

New Parasite on the Vine.†—Under the name *Uredo Vialæ* Prof. G. V. Lagerheim describes a new species, exceedingly destructive to the vines in Jamaica. The uredo-form alone is known, appearing as minute pustules, which cover more or less completely the under side of the leaves.

Trichophyton tonsurans parasitic on Cervus elaphus.‡—Dr. K. Eckstein finds the hairs of a specimen of *Cervus elaphus* attacked by this fungus, the mycele of which causes the disease of man and other animals known as "Herpes tonsurans." It causes disorganization of the cells of the hair, the entire pith passing over into a uniform granular mass, and the hairs finally falling off. Infection may be brought about by the carriage of the spores of the fungus by animal parasites.

"Bladder-rust" of the Weymouth Pine.§—In addition to the well-known *Peridermium Strobi* and *Pini*, Dr. H. Klebahn now describes a third species, *P. Cornui*, parasitic on *Pinus sylvestris*, and probably on allied species. Its teleutospore-form is *Cronartium asclepiadeum;* and the author gives a *résumé* of the genetic connection between the various teleutospore-forms *Coleosporium* and *Cronartium*, and the æcidio-forms *Peridermium*.

Parasitism of Tremella Dulaciana on Agaricus nebularis.‖—M. C. Roumeguère describes a new fungus parasitic on *Agaricus nebularis*, to which he has given the name of *Tremella Dulaciana*. The parasite measures 5 mm. in length and 1 mm. in height. The head consists of a gelatinous globular whitish mass, showing to the naked eye a number of threads forming tortuous circles, and somewhat recalling *Peziza Tamaricis*.

Thelephoreæ.¶—Mr. G. Massee publishes a monograph of this order of Fungi, prefixed by a description of its general characters. There occur within the order all the types of hymenium characteristic of the

* Amer. Natural., xxiv. (1890) pp. 177–80 (1 pl.).
† Comptes Rendus, cx. (1890) pp. 728–9.
‡ Zool. Anzeig., 1890, pp. 40–1.
§ Hedwigia, xxix. (1890) pp. 27–35. Cf this Journal, 1889, p. 564.
‖ Rev. Mycol., xii. (1890) pp. 1–3.
¶ Journ. Linn. Soc. (Bot.), xxv. (1889) pp. 107–55 (3 pls.), and xxvii. (1890) pp. 95–205 (3 pls.).

four principal groups of the Hymenomycetes, the Agaricineæ, Polyporeæ, Hydneæ, and Clavarieæ; and the author regards it, therefore, as constituting the base and starting-point in the evolution of the Hymenomycetes, excluding the Tremellineæ, which are more nearly allied to the Uredineæ. Two types of hyphal structure are met with in the order:—(1) Having thin walls, with little or no tendency to become gelatinous externally, numerous transverse septa, and usually much branched; and (2) walls very thick, with a decided tendency to become gelatinous or mucilaginous outside, not septated. Transitional forms connect the two extremes.

The following two new genera are described:—*Heterobasidium:* Resupinato-effusum, secernibile; subiculo compacto arido; basidia bi-monospora; sporæ septatæ, fuscidulæ. The lowest member of the order, and intermediate between the Hymenomycetes and Hyphomycetes. *Asterostroma:* Resupinato-effusum; subiculo fibrilloso arido; hyphis stellatis brunneis immixtis; sporæ albæ, hyalinæ. Separated from *Corticium*, to which it is nearly allied, by its brown stellate hyphæ in the subiculum, and the dry minutely pulverulent not waxy hymenium. A diagnosis follows of the three genera *Hymenochæte*, *Corticium*, and *Stereum*, and of all their known species, among which several new ones are described.

British Gastromycetes.*—Mr. G. Massee reviews the structure and systematic position of this family of Fungi. He disagrees from De Bary's idea of the derivation of the Gastromycetes from the Polyporeæ, and suggests rather that they are descended from the Ascomycetes through the Tuberaceæ, by the gradual conversion of asci into basids, the Hymenogastreæ being regarded as the primitive stock of the Gastromycetes. The group is divided into the orders—Hymenogastreæ, Sclerodermeæ, Nidularieæ, Podaxineæ, Lycoperdeæ, and Phalloideæ, diagnoses being then given of the twenty-one genera and seventy-four species at present known in Great Britain.

Protophyta.

a. Schizophyceæ.

Classification of Diatoms.†—Dr. G. B. De Toni proposes a new classification of the Diatomaceæ, of which the following are the primary divisions:—

I. Evolutio valvarum bilateralis, i. e. systema striarum v. costarum circa lineam medianam longitudinalem (raphem v. pseudoraphem) dispositum.
  A. Valvæ nodulis medianis instructæ (*Noduliferæ* Deby); raphis genuina præsens (*Rhaphideæ*). (Naviculaceæ, Amphitrophidaceæ, Cymbellaceæ, Cocconeidaceæ, Gomphonemaceæ, Achnanthaceæ.)
  B. Valvæ utræque nodulo mediano genuino carentes v. ob absentiam v. abbreviationem striarum costarumve spatium longitudinale raphem simulans (pseudoraphem) nodulosque et medianos et terminales (pseudonodulos) præbentes

* Ann. of Bot., iv. (1890) pp. 1–103 (4 pls.).
† Notarisia, v. (1890) pp. 885–922.

(*Pseudoraphideæ*). (Nitzschiaceæ, Cylindrothecaceæ, Amphipleuraceæ, Surirellaceæ, Diatomaceæ, Meridionaceæ, Trachyspheniaceæ, Plagiogrammaceæ, Licmophoraceæ, Striatellaceæ, Entopylaceæ, Eunotiaceæ.)

II. Evolutio lateris valvaris centricus ita ut sculptura radialiter e puncto mediano oriens disposita sit (*Araphideæ* v. *Cryptoraphideæ.*)

A. Valvæ non orbiculari-rotundatæ, sed 3-multi-angulatæ v. elliptico-constrictæ, sæpe processus varios gerentes, zona seu facies connectivalis sculptura ab ea faciei valvaris diversa et analoga ornata. (Biddulphiaceæ, Hemiaulidaceæ, Isthmiaceæ.)

B. Valvæ orbiculari-rotundatæ, nonnunquam processibus aciculis v. spinis instructæ ; zona seu facies connectivalis plerumque exstria, subrectangularis v. nonnunquam undulato-constricta. (Melosiraceæ, Xanthiopyxidaceæ, Coscinodiscaceæ, Eupodiscaceæ, Heliopeltaceæ, Asterolampraceæ.)

C. Valvæ tum æquales tum inæquales, imperfecte siliceæ, cornubus spinis setisve instructæ, zona connectivalis plus minus turgida, singula, breviter cylindracea. (Chætoceraceæ.)

D. Valvæ conoideæ v. acuminatæ, sæpius calyptra v. stylo terminatæ, per laminas parce siliceas numerosas apparenter imbricatas striatas conjunctæ. Frustula subinde per stylum calyptramve consociata. (Rhizosoleniaceæ.)

Pleurosigma angulatum.*—Dr. H. Van Heurck describes a series of preparations of this diatom, accompanied by photograms, made with an objective of 2·5 mm. focal length and a numerical aperture 1·63. The alveolæ or "pearls" exhibit themselves under the form of minute points, each surrounded by a crown of six secondary pearls, really intermediate between the primary ones. A careful examination of the photograms shows that the cause of this appearance is that the alveolæ are not really round, but hexagonal, the "secondary pearls" being the result of imperfect focusing of the angles of the network. This view is confirmed by a comparison with the structure of *Coscinodiscus excentricus*. It is further shown that the valve of *Pleurosigma* consists of two layers, and that the alveolæ are hollowed out in the substance of the valve.

Fossil Diatoms of Japan.†—Prof. J. Brun and J. Tempère describe the numerous new and marine species of diatom found in the argillaceous calcareous deposits of Sendaï and Yeddo ; the most noticeable peculiarity of which is that they have been fossilized not by silica but by calcium carbonate, which has filled all the valves in the crystalline state, accompanied by small crystals of black oxide of iron.

β. Schizomycetes.

Structure of Bacteria and allied Organisms.‡—Prof. O. Bütschli deals with the finer structure of Bacteria in a monograph, the object of

* Bull. Soc. Belge Microscopie, vi. (1890) pp. 10–2 (5 photograms).
† Mem. Sci. Phys. et Hist. Nat. Genève, xxx. (1890) 75 pp. and 9 pls.
‡ 'Ueb. den Bau d. Bacterien und verwandter Organismen,' 1890, 37 pp. (21 figs.).

which is to demonstrate the proposition that these organisms are nucleated bodies. The ultimate structure of these minute bodies is divided into two parts, an outer harder layer and an inner softer part, the central body. The former is further distinguished from the central body by being less stainable with the ordinary pigments. In both a reticulated appearance is discoverable with high magnifying powers, and on section this reticulation or network imparts a honeycombed appearance to the object. At the points of intersection of the network are frequently seen red globules of variable size. These red globules, which are very frequent in the sulphur bacteria, are supposed to consist of sulphur in some viscid condition. Their exact significance seems doubtful. One point on which the author expresses himself confidently is that when a flagellum is present it is continuous with the outer layer. The central or chromatic part of the micro-organism is to be regarded as the nucleus.

Micrococcus versatilis.*—This micro-organism, which Dr. C. Delgado and Dr. C. Finlay presume to have some direct connection with the appearance of yellow fever, has been obtained by the usual methods, not only by these authors, but also by Dr. Sternberg and others from the juices and tissues of persons affected with or dead of yellow fever. The authors have obtained it from the serum of artificial blisters, and Sternberg from the skin of healthy but unwashed persons living in places where the fever is endemic. The name originally given to this micrococcus by Delgado and Finlay was "Tetragenus febris flavæ," but they now accept the new name proposed by Sternberg.

The best procedure for obtaining *M. versatilis* is to inoculate peptonized gelatin and keep it in the incubator at a temperature of 30°–32°. When a deposit forms at the bottom of the gelatin, gelose in Esmarch's tubes is inoculated therewith, and the tubes kept at a temperature of 30°–32°. Colonies began to appear in from two to six days, according to the season of the year and the activity of the germs cultivated. The colonies are round, with smooth edges, transparent, of a straw-yellow colour, but become opaque as they grow older. The colonies below the surface are more fusiform and deeper coloured.

The name *versatilis* was suggested by the different appearances presented by the colonies, their variable colour, and the diverse sizes of the micrococcus, which is chromogenous, and developes in true tetrads.

Bacillus of the Olive Tubercle.†—Dr. L. Savastano, who in 1887 announced that this disease of olive trees was due to a specific bacillus, now communicates some further characteristics of the micro-organism. Successful cultivations are made from commencing tumours; when these are older it is necessary to take the internal parts near the regeneration area. The bacillus is of medium size, and three or four times longer than broad. It is usually single, but may be in pairs. The ends are slightly rounded. The colonies are variable in shape, but usually round to oval. The cultivations succeeded well on the usual media, and slowly liquefied gelatin in May and June, but not from January to April. Spore-

* Journ. Anat. et Physiol., xxv. (1889) pp. 223-4.

† Atti Reale Accad. Lincei—Rend., v. (1889) pp. 92-4. Cf. this Journal, 1887, p. 286.

formation was not observed. The microbes were easily stained with the usual anilin dyes. The same micro-organism was detected in material sent from the olive plantations of Puglia, Calabria, about Vesuvius, and Sorrento.

Three series of inoculation experiments were made, and their results were that healthy olive plants raised from seed and not from cuttings, showed tumours in four or five weeks, while the control plants were unaffected. Secondly, that other kinds of plants inoculated with this bacillus never showed any kind of tumour. Thirdly, that olives inoculated with micro-organisms pathogenic to other plants were unaffected. Hence the author concludes that the *Bacillus Oleæ tuberculosis* is the specific cause of this disease of olive trees.

Influence of the kind of Nutriment of a Bacillus on the Diastase secreted by it.*—M. W. Vignal has found, from a series of experiments which he has made from some bouillon cultivations of *Bacillus mesentericus vulgatus*, that up to a certain degree the nutrient media exert a definite influence on the quantity of the excretory products secreted by this bacillus. This influence made itself appreciable to a slight degree on the addition of sugar or starchy material, and to a significant extent on the addition of casein. The excretory products always quickly disappeared from the cultivation fluids.

Bacillus mesentericus vulgatus.†—In a long monograph, M. W. Vignal treats exhaustively of the potato bacillus. He discusses its wide diffusion in water, in air, in the digestive system, its morphological, biological, and cultivation characters, and the way in which it is propagated and multiplies. The author then passes on to the influence which warmth and antiseptic media exert on the potato bacillus, and describes the changes which the bacillus induces in albuminous substances, gelatin, casein, sugar, starch, and vegetable matter, and concludes with remarks on the products of metabolism.

Existence of Micro-organisms in the Tissues of the higher Plants.‡—M. E. Laurent, in reviewing the connection of bacteria and the higher plants, points out that while there are few bacterial affections among plants, there are a great number in the animal kingdom. In animals, the bacteria overcome the resistance of the living cells by the production of toxic matter, which is rapidly diffused throughout the organism by the blood, while in plants the migrations of these parasites and their secretions is more difficult. The author sums up the results of his own experiments, and also those of others, as to the existence of foreign organisms within vegetable tissues, by denying the possibility of their existence under normal conditions. But although this statement is to be regarded as true for most cases, exceptions to the rule are pointed out. Thus several Nostocaceæ live within the tissues of various living plants, while a more remarkable example of symbiosis between vascular plants and microbes is offered by the Leguminosæ.

* Archiv de Méd. Experiment. et d'Anat. Pathol., 1889, p. 547. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 61.

† 'Contributions à l'étude des Bactériacées,' Paris, 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii (1890) pp. 61–2.

‡ Bull. Soc. Roy. Bot. de Belgique, xxviii. (1889) pp. 233–44.

The author further gives a short notice * of some experiments which prove that bacteria are absent from the vessels of plants. He regards the theory of Béchamp as "the result of a lively imagination altogether devoid of experimental control."

Adametz, L.—**Ueber einen Erreger der schleimigen Milch.** (On a micro-organism, the cause of viscous milk, *Bacillus lactis viscosus.* *Milchzeitung*, 1889, p. 941.

Buchner, H., and others.—**Untersuchungen über die bakterienfeindlichen Wirkungen des Blutes und Blutserums.** (Investigations on the destructive influence of blood and blood-serum on Bacteria.) 1. Vorbemerkungen (Preliminary remarks), von H. Buchner. 2. Ueber den bakterientödtenden Einfluss des Blutes (On the fatal influence of blood on Bacteria), von H. Buchner u. Fr. Voit. 3. Welchen Bestandtheilen des Blutes ist die bakterientödtende Wirkung zuzuschreiben? (To what constituents of the blood is the fatal influence on Bacteria due?), von H. Buchner u. G. Sittman. 4. Versuche über die Natur der bakterientödtenden Substanz im Serum (Experiments on the nature of the fatal substance in the serum), von H. Buchner u. M. Orthenberger.
Arch. f. Hygiene, X. (1890) Heft 1, 2, pp. 84–173.

Celli, A., et G. Guarnieri.—**Sulla etiologia dell' infezione malarica.** (On the etiology of malarial infection.) *Archivio per le Scienze Mediche*, XIII. p. 307.

Daehle.—**Beobachtungen über einen Antagonisten des Milzbrandes.** (Observations on an antagonist of charbon.) Thesis, Kiel, 1889.

Fokker, A. P.—**Die Grundlagen der Bacteriologie.** (The foundations of Bacteriology.) Rede, gehalten beim Niederlegen des Rectorats der Universität Groningen. Leipzig, 8vo, 1889.

Hansgirg, A.—**Ueber neue Süsswasser- und Meeresalgen und Bakterien, mit Bemerkungen zur Systematik dieser Phycophyten und über den Einfluss des Lichtes auf die Ortsbewegungen des** *Bacillus Pfefferi* **nob.** (On new freshwater and marine Algæ and Bacteria, with remarks on the systematic position of these Phycophyta, and on the influence of light on the locomotor movements of *Bacillus Pfefferi* nob.
Sitzber. d. Kgl. Böhmischen Ges. d. Wissensch. in Prag, Prag, 1890, 8vo, 2 pls.

Lewek, Theodor.—**Ueber den Wachsthumseinfluss nicht pathogener Spiltpilze auf pathogene.** (On the action exercised by some non-pathogenic Bacteria on the growth of pathogenic Bacteria.)
Ziegler's Beiträge zur pathol. Anatomie und zur allgemeinen Pathologie, VI. p. 3.

Lortet.—**Des microbes pathogènes des eaux potables.** (The pathogenic microbes of drinking waters.) *Lyon Méd.*, 1890, No. 13, pp. 450–4.

Mandry, Gr. D.—**Zur Kenntniss des Friedländerschen Bacillus und einer Abart desselben.** (Contribution to our knowledge of the bacillus of Friedländer, and on a variety of this micro-organism.) *Fortschritte der Medicin*, VIII. p. 207.

Metchnikoff, E.—**Étude sur l'immunité.** (On immunity.) 3e mémoire.
Annales de l'Institut Pasteur, IV. p. 194.

Plehm, Dr. F.—**Beitrag zur Lehre von der Malaria-infection.** (Contribution to the knowledge of malarial infection.) *Zeitschrift f. Hygiene*, VIII. p. 78.

Wagner, K. E.—**De l'action de quelques substances médicinales sur la croissance des cultures du bacille de la tuberculose.** (On the action of some medicinal substances on the growth of cultivations of the bacillus of tuberculosis.)
Wratsch, 1889, No. 42 (Russian).

Zimmermann, O. E. R.—**Die Bakterien unserer Trink- und Nutzwasser, insbesondere des Wassers der Chemnitzer Wasserleitung.** (The Bacteria of our drinking and service waters, and especially those of Chemnitz.)
1st series, Chemnitz (Martin Bülz), 1890, 8vo, 106 pp.

* Bull. Acad. Roy. de Belgique, lx. (1890) pp. 468–71.

MICROSCOPY.

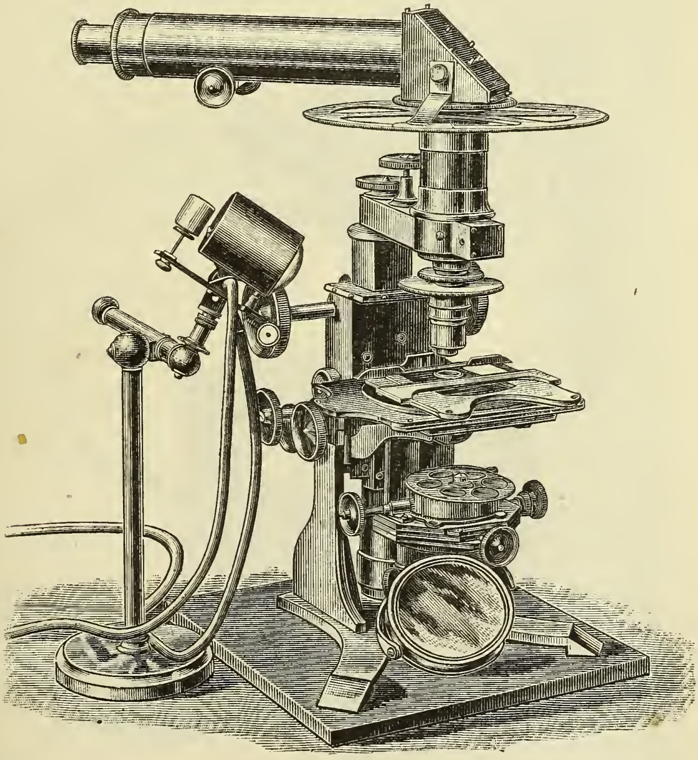
a. Instruments, Accessories, &c.*

(1) Stands.

Braham's Universal Microscope.—The following description has been communicated to us by Mr. Philip Braham, of Bath:—

"The original design of the instrument was based on the most improved Microscope, devised by the late Andrew Ross: but the modi-

Fig. 50.



fications I have made with a view to facilitating special investigations are considerable.

Fig. 50 shows my application of a rectangular prism, giving the

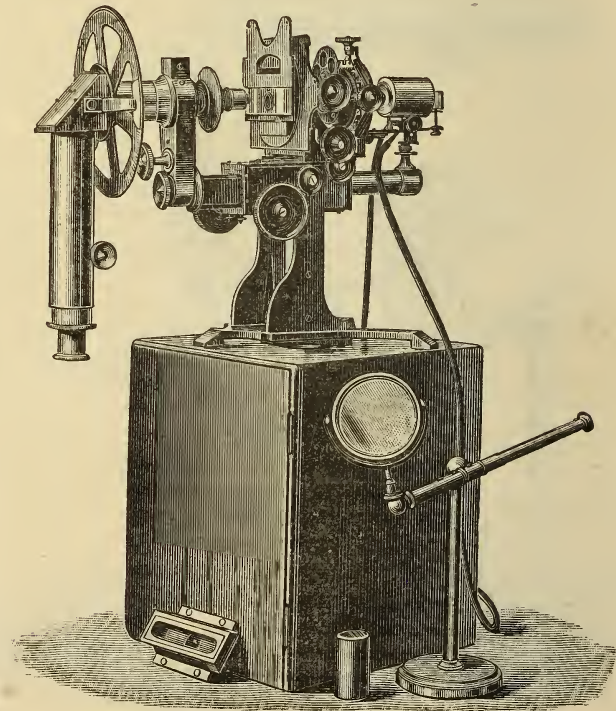
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

observer an easy position for examining objects in liquids, and the means of measuring the angles of crystals.

The angles of crystals are measured by cross-wires in the focus of the eye-lens, a divided circle attached to the body of the instrument, and a Vernier attached to the side of the brasswork, carrying the rectangular prism, which is adjusted by three screws, so that the hypothenuse is exactly at an angle of 45° with the optic axis. The adjustment is made by placing on the stage a slip of glass, ruled with fine cross-lines, which are made to coincide with the cross-wires in the eye-piece.

The divided circle can be turned by rotating the tube at right angles

Fig. 51.



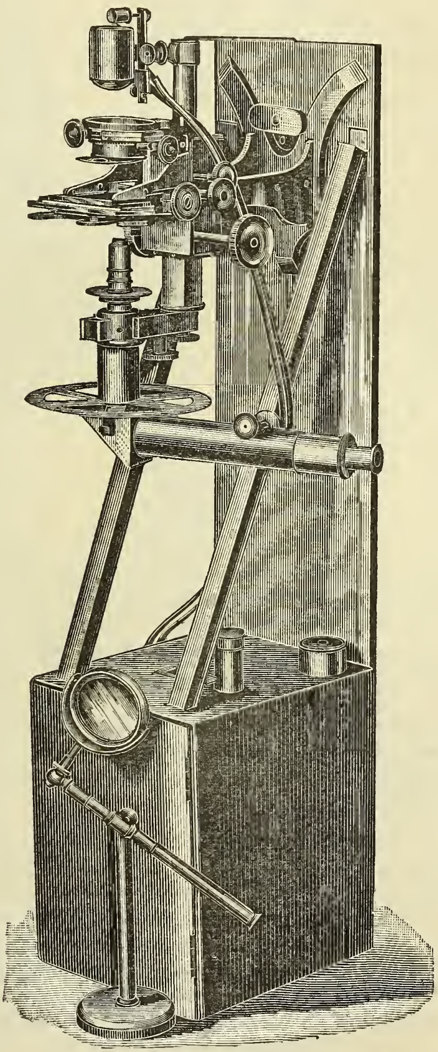
to the optic axis. The magnified image of the crystal also rotates, the angles being measured by the coincidence of the sides of the crystal with the cross-wires in the eye-piece.

This arrangement is also useful in observing phases in polarization, the tube carrying the polarizing prism on the substage being rotated by clockwork, and four pins making electrical contact and ringing a bell,

by which every quarter revolution is marked, and attention called to the changes visible.

The limelight illuminator is shown in position for illuminating opaque objects, and a light from the mirror through coloured glass gives a good background for a variety of objects.

Fig. 52.



The limelight apparatus shown is conveniently clean and devoid of smell, and gives out very little heat. It can be used for oblique, opaque or transparent illumination, and can be varied in intensity. It consists of a diminutive limelight on a condenser stand, with an adjustable plano-convex lens in front. By varying the distance of the plano-convex lens in front of the limelight either convergent, divergent, or parallel rays can be obtained and projected in any direction.

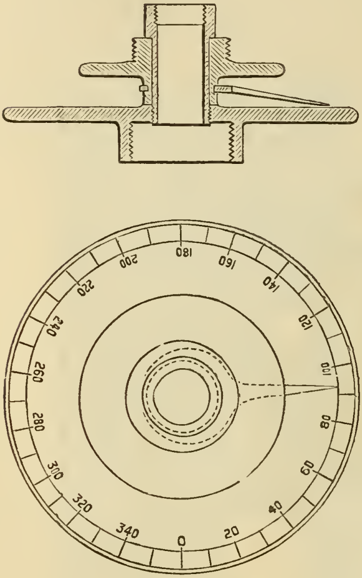
Fig. 51 shows the instrument in position to project an image of an object on a sheet of paper on the table for sketching; the limelight being attached in the place of the mirror.

Fig. 52 shows the adjustment of the instrument in an inverted position. A board is attached to the box, and two struts are applied; the Microscope is then clamped to the upper part of the board, the feet fitting into corresponding notches in the board. This enables the observer to examine objects from beneath, whilst objects in liquids and tubes are seen free from cylindrical aberration by immersing the tubes in a cell shown on the table in Fig. 51.

The interior of crystals or gems can be microscopically explored by immersing them in equally refractive liquids.

Fig. 53 shows my rotating nosepiece, consisting of a screw fitting to the objective end, and a divided circle fitting to the objectives and rotating. An index pointer sprung on to the nozzle shows the angle of rotation; the other end of the rotating tube is adapted to receive the analysing prism or a double-image prism, which can be used for measuring the angles of crystals by rotating the magnified extraordinary image round the ordinary. It can also be used in testing objectives."

FIG. 53.



Dumaige's "New Model of Microscope." *—M. Fabre Domergue describes and figures what he calls "un nouveau modèle de Microscope," constructed by M. Dumaige of Paris. We cannot, however, discover anything new in the instrument, and the only points to remark on are:—(1) the teeth of the rack are of ovoid section, and are set obliquely (a plan we believe not previously adopted in a French Microscope); (2) the carrier for the Abbe condenser is of reduced size, so as not to require the stage to be raised too much above the base; and (3) the pivot on which the condenser carrier turns is fixed to a slight prolongation from the right posterior corner of the stage, which the author considers to be "a very great advantage; it constitutes for the hand that works the micrometer-screw a kind of natural support, and allows the fingers much ease and suppleness in using the screw."

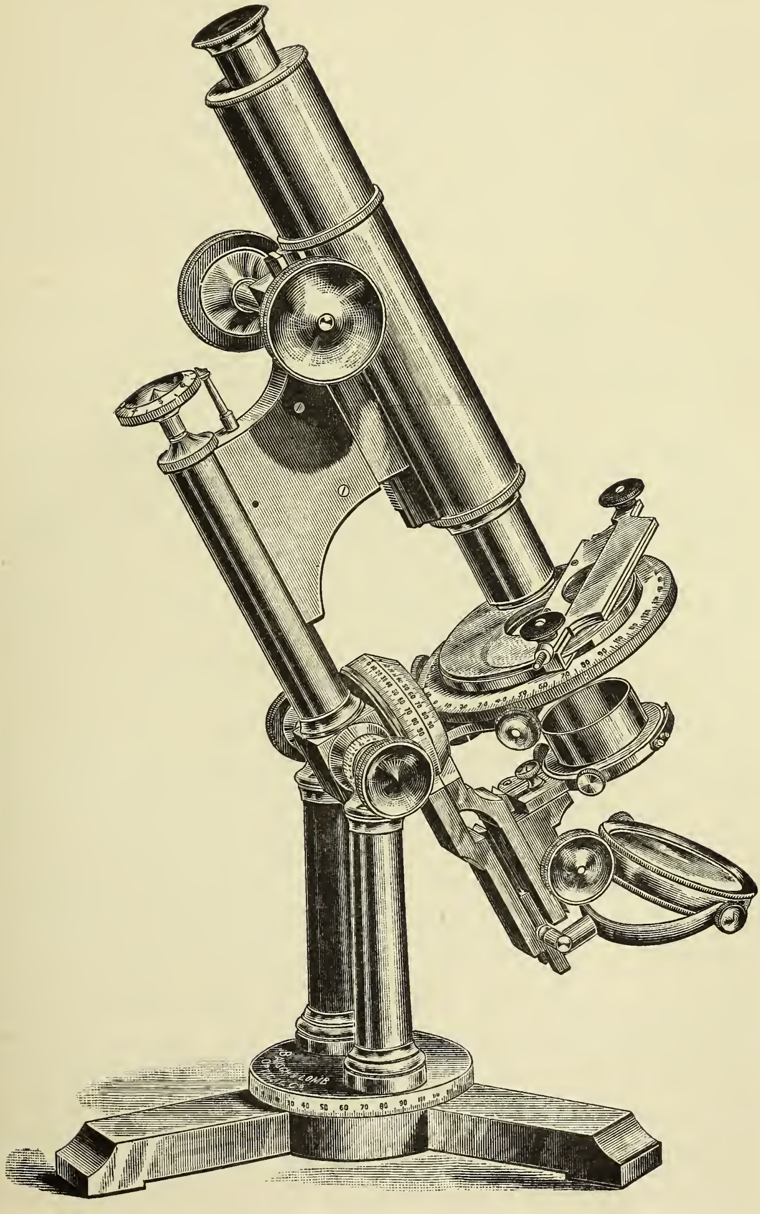
M. Fabre Domergue refers to condensers as having been "completely neglected ten years ago!" The introduction of the Abbe condenser, he says, imposes upon constructors the necessity of modifying the old models of stands so as to allow of the introduction of condensers beneath the stage.

Hart's Microtome-Microscope.†—The following is the abstract of a paper by Dr. C. P. Hart, as printed in the Proceedings of the American Association for the Advancement of Science, under the title of "*A new, cheap, useful, and quickly constructed adjustable Microtome.*"

"This instrument is nothing more nor less than a Bausch and Lomb "Microscope-stand, converted into a microtome by the following changes: "—Having removed the substage, the slide-carrier clips, the objective "adapter, and the draw-tubes, a suitable razor-blade is permanently fixed "to the slide-carrier, so as to have a corresponding universal lever move-

* Ann. de Micrographie, ii. (1890) pp. 164–7 (1 fig.).
† Proc. Amer. Assoc. Adv. Sci. for 1885 (1886) p. 356.

Fig. 54.



Hart's Microtome-Microscope.

"ment parallel to the glass stage. The imbedded substance is then carried "down the main tube of the instrument (which is placed in a horizontal "position) until it presses gently against the microtome-knife, when it is "fixed in position within the tube by means of the main draw-tube, the "diaphragm of which, either directly or by means of a small wooden "cylinder, is brought in contact with the distal extremity of the substance "to be divided, and this acts as a plug or follower to retain it in position "within the tube. Then, having moistened the knife, and, if necessary, "the substance to be operated on also, the slide-carrier, and with it the "microtome-knife, is made to pass through a sort of revolving cutting "motion, by which the sections are made. These sections may be made "of any degree of delicacy by means of the micrometer-screw attached to "the instrument."

The notion of converting such a Microscope into such a microtome seemed to be so unique in the novelty of its originality (it is difficult to hit on the exactly appropriate designation) that we imported the instrument from the United States, and give an illustration of it in fig. 54, which shows the razor-blade and slide-carrier in the form designed by Dr. Hart.

Alterations in Nobert's Microscope.*—Herr Kayser describes some alterations made on a Nobert Microscope. He particularly mentions the simple reading arrangement constructed by him, which is just as serviceable as a microscopical one composed of eye-piece and objective, but it does not invert the image. This arrangement consists of a small tube, containing only a thread and a plano-convex lens. Close to the eye comes the thread stretched horizontally, and then the lens, with convex side in front, at such a distance that the image of the thread is distinctly seen by the passage of the rays through the lens, and reflection at its plane silvered surface. A narrow strip of the silvering is removed in a direction passing through the centre, and at right angles to the thread. Consequently, when the distance of the tube is suitably adjusted, the eye can see a division through this central space. In order to have the division, but not the thread, more strongly magnified than in this, the simplest case, a second plano-convex lens of suitable focal length can be added immediately on the plane silvered face of the lens. Here two equal lenses of 10 mm. diameter and 25 mm. focal length are combined. On the thread end of the tube a white paper screen inclined at 45° with central aperture is fitted for the illumination of the thread. This small reading arrangement is fastened to the object stage, while an ivory rod with a range of 80 mm. divided into half millimetres, and fixed vertically on the Microscope-tube, can be displaced with the tube. A screw with large drum divided into 50 divisions serves to raise or lower the stage by slow degrees. Since the tenth of the division can be easily read, an arrangement is thus attained which, over a very large interval (80 mm.), gives an adjustment and a measurement which is exact up to 1/1000 mm. This is of importance, for instance, for microscopical measurements of the refractive indices of transparent plates. By means of the fine screw, the error of the divisions on the scale can be tested, and it is especially serviceable in

* Schrift der Naturforsch. Gesells. Danzig, vii. (1890) pp. xi.–xii.

adjusting objectives of short focal length and immersion systems, which must otherwise be done by testing, and consequently with danger to the apparatus. In determining the refractive index of a transparent plane parallel plate, Herr Kayser proceeds as follows. The refractive index is $= \frac{D}{D - d}$ where D and d are given by three readings on the scale, when the adjustment of the Microscope is made:—1. On the support of the plate. 2. On the upper face of the plate, after it has been put on the stage. 3. On the support as seen through the plate. The readings 1 and 2 give D, the readings 1 and 3 d. This method is, however, not sufficiently precise. Another and more exact method, with experimental proof, will be given later.

(3) Illuminating and other Apparatus.

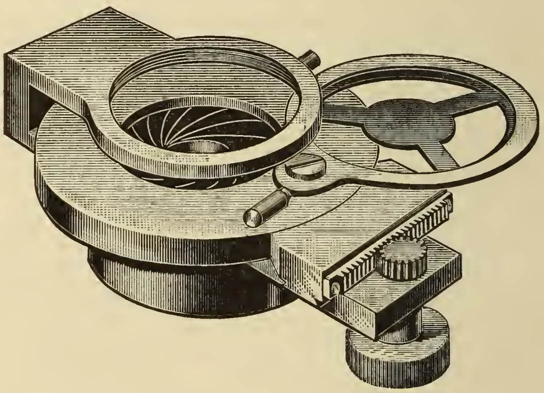
Mayall's "Jewelled" Fine-adjustment.—At the April meeting of the Society, Mr. J. Mayall, junr., referred to an improved form of fine-adjustment constructed and exhibited by Messrs. Powell and Lealand, for the production of which he was himself chiefly responsible. He said that during the past ten or twelve years, several forms of fine-adjustment had been brought to the notice of the Society, but the principal aim in most of them had been economy of production or lowness of price, without regard to improving on the best existing forms. In the new form exhibited the chief aim had been to construct a fine-adjustment that should combine extreme sensitiveness of action with accuracy and probable durability, beyond what had previously been attained. With this view he had carefully considered every known form of fine-adjustment, and had selected that of Messrs. Powell and Lealand, as representing the highest type of construction yet devised, with which to test the possibility of improvement. The essential feature in the improvement was the application of what watchmakers would term a "jewelled movement." The whole of the contact surfaces by which the fine-adjustment was actuated consisted of polished steel and agate, the intention being to reduce the friction as much as was consistent with steadiness of motion. The perfection and durability of jewelled mechanism was a great feature in the highest class of clocks and watches; the most delicate parts of Nobert's ruling machine were jewelled, as were also the bearings in Dr. Hugo Schröder's feeling level for testing the accuracy of plane surfaces. Those who were familiar with Powell and Lealand's fine-adjustment, as previously constructed, would understand the extreme difficulty of improving the mechanism substantially, for it was the outgrowth of long experience and of the most conscientious devotion of expert mechanicians to the task of providing a perfect focusing movement. No other fine-adjustment had reached the same high standard of construction, which was probably due to the fact that during the fifty years that had elapsed since its first production, the makers had kept steadily to the same system, only varying the minor details of the mechanism as experience critically suggested in the direction of improvement.

The application of polished steel and agate bearings throughout the mechanism was intended to reduce the friction, and thus render the

action more sensitive without introducing unsteadiness. The result attained was undoubtedly an improvement on the whole system, though the cost would probably limit the application to the few instruments required for very special and difficult investigations in microscopy. For high-class photomicrographic work, or where preparations had to be retained under observation for long periods of time, the new mechanism should be particularly useful, for the greater solidity of the general construction clearly pointed to greater precision of action and increased stability.

Messrs. Bausch & Lomb's Condenser Mounting.*—We give a figure of a condenser mounting with iris diaphragm recently designed by Messrs. Bausch and Lomb. This mounting provides a movement for the

Fig. 55.



diaphragm by rack and pinion. It has in addition a recess for receiving central stops and blue glass.

It can be attached to an adjustable substage or to a substage fixed to the stage, and may be used with the high and low angled Abbe condenser.

New Stage Micrometers.—At the May meeting of the Society, Mr. E. M. Nelson called attention to a new stage micrometer, produced by Messrs. Powell and Lealand, and so excellently ruled as to be worthy of remark:—"It comprises 100ths and 1000ths of an inch, and 10ths and 100ths of a mm., there being 10 divisions of each set; the finer divisions of ·001 in. and ·01 mm. being placed in the centre, the ·01 in. being on the one side, and the ·1 mm. on the other, respectively, a guiding line being ruled at right angles to them. The lines are fine, 1/30,000 in., and are blackened in, and mounted in balsam. The lines are straight, and evenly ruled. With regard to the spacing, I have made exhaustive comparisons with fine micrometers by Rogers and Zeiss, and some others not quite so perfect. Upwards of 240 screw micrometer

* Amer. Mon. Micr. Journ., xi. (1890) pp. 25–6.

measurements were made, and the work carried on under hypercritical conditions. An account of these may be of interest. First, a magnification of 1200 diameters by means of a suitable immersion lens was employed for the finer ruling, and for the coarse a dry 1/6 × 600 diameters; the screw micrometer was on an independent mounting. Care being taken with regard to the illumination, &c., a critical image of the lines was obtained. The order in which the lines were taken was from left to right, as seen in the instrument; each interval was then designated by consecutive letters of the alphabet. The intervals were then most carefully wired, and each value set down under its corresponding letter; when the ten spaces were finished they were meaned.

It was then easy to see which interval differed from the mean, and to calculate how much. In the same way comparison can be made with any other scale, it matters not whether it is ruled in inches or mm. It is most important that both the instrument and the observer be tested. To this end I proceeded as follows. The screw value of 20 intervals on a badly ruled scale was written down as above, the paper was then put away, and the operation performed again.

On comparing the two papers, the screw values of seven intervals were identical, 12 different by one division, and one by two divisions. This error of two divisions occurrèd in the interval H, the first reading being 1033, and the second 1031. On careful re-examination of this interval, I came to the conclusion that the first reading was the bad one, and that the true value was 1031 or 1032. On substituting this last value in both sets of readings, the 20 intervals meaned precisely alike, viz. 1038. As this forms a suitable illustration of the work, I append the two columns. With the exception, therefore, of the interval H, the screw readings may be taken as true to ± 1. The point, therefore, we have to determine, is the value of ± 1. The mean 1038 being the value in divisions of the screw-head, for 50 μ, the value of one division consequently = ·000001897 in., or less than 1/500,000 in.

This might be called 'the constant of the instrument, and observer.' We next have to find the greatest errors of the intervals from the mean; G is the greatest, and S the least. Calculation shows that G is 1/20,000 in. too large, and S 1/40,000 in. too small.

But, on returning to Powell's scale, we find a much closer agreement than this. Taking the ·001 in. first, we find the mean to be 628·0. Three out of the ten intervals agree to that mean to ± 1: this being 'the constant of the instrument and observer,' they are without sensible error. Four intervals agree to ± 2, which is less than 1/300,000 in.; two lines B and H agree to ± 3, which is less than 1/200,000, and one interval G is + 4, viz. 1/157,000 in., too large. Now, as we found that ± 1 was the limit of observation, we may say that the scale, with the exception of B, G, and H, has no sensible error. Practically speaking, G is the only interval that is out, and its error is small in comparison with other scales.

The next scale is the 1/100 mm.

The ·01 mm. is too small a quantity to treat in the above way; it must be left until we have objectives as perfect as those we have at present, but of double their power.

All that can be done is to take several of the divisions. Eight sets

of three each were measured on Powell's new scale: the variation from the mean was less than 1/200,000 in. Rogers' is a very well ruled scale; it is, however, difficult to observe, the lines being without pigment, and it is mounted dry. The lines under these circumstances present the usual black and white diffraction images. It is, on that account, very difficult to maintain an equable focus during measurement. In Rogers' scale, the greatest error is in interval G, where it amounts to four divisions, or somewhat less than 1/100,000 in. Thirteen out of twenty intervals have practically an insensible error. One cannot speak with the same certainty with regard to this plate as to the others, because of the focal difficulty. Different readings gave discordant results; therefore, in this case, more must be allowed for the 'constant of the observer and instrument.' With regard to the 1/10ths of a mm. on Powell's scale, they were examined by a power of 600 diameters by a dry lens. The mean was 987; six intervals had no sensible error, but C and G had an error of three divisions, which is equivalent to 1/100,000 in.

Rogers gave a very similar result.

The error of the interval D, in the Zeiss scale, was 1/30,000 in.

I next compared the length of the mm. on the three scales, that is Powell's, Rogers', and Zeiss', with each other. I detected a slight but insensible difference of ± 1. All that now remains to be done, is to compare the inch and the mm. scale on Powell's plate. By measurement, we found that 30 μ gave a screw value of 741·25; therefore, the value for ·1 mm. would be 2470·8, and the value for 1/1000 in.

$$\frac{\cdot 001 \times 2470\cdot 8}{\cdot 003937} = 627\cdot 59.$$

The value actually measured was, as we saw above, 628·0; here again there is no sensible discrepancy. In conclusion, I feel sure that such an accurately ruled micrometer, and one so clear to read, will prove extremely useful to microscopists at large.

Before closing, I would like to bring to your notice a screw micrometer made for me by Mr. Powell, which contains some slight modifications from the usual forms, which practical experience has suggested to me.

First, with regard to the lens portion, I have substituted a compensating positive for the old form of Huyghenian or Ramsden. This yields far better images when making measurements with apochromatic and ordinary objectives. I have so arranged it that the compensating eye-lenses of different foci are interchangeable. In fact, no special lens is required, you use your ordinary working eye-piece, whatever that one may be. This is, of course, a great advantage: bacteria, for instance, require a high-power eye-piece micrometer, while such a power would be useless on an ordinary object.

Therefore, the ability to regulate your eye-piece power to the object to be measured, will meet a long felt want.

Next let me say that I entirely disapprove of having two movable threads; at the outset 'the constant of the instrument' would be doubled; moreover, I am confident that a movable zero is a mistake.

I have, therefore, considerably altered this portion of the instrument by making the screw portion, together with the fixed zero thread, movable in the other part, which might be aptly termed 'an eye-piece

adapter.' By this we secure the advantage of the double movable thread, without the additional error of the double movable thread, and this, moreover, without losing the convenience of a fixed zero.

This enables you to span your object at equal distances on either side of the optic axis, without disturbing the centricity of the eye-piece. A guiding line has been added, because an error might creep in unless measurements are made with precisely the same portion of the wires.

The divisions on the screw head have been made white on a black ground, on account of their being easier to read in a darkened room. A cap to protect the threads from dust and injury, &c., is provided, as the threads are no longer inclosed between the lenses, as in the Huyghenian form.

An iris diaphragm is placed below the threads and as close to them as possible.

In spanning the stage micrometer, it will be found better to take the readings from centre to centre of the lines, by doing which you avoid the diffraction which is always present at edges.

The measurement of all objects should be performed under a wide angled cone of illumination, so that the diffraction at the edges may be minimized as much as possible."

Two Readings of Scale 50 μ.

				diff.
A	1038	A	1038	0
B	35	B	36	+ 1
C	37	C	36	− 1
D	36	D	37	+ 1
E	30	E	29	− 1
F	37	F	37	0
G	65	G	64	− 1
H	32	H	32	0
I	29	I	30	+ 1
J	48	J	48	0
K	34	K	33	− 1
L	29	L	30	+ 1
M	40	M	40	0
N	45	N	45	0
O	38	O	37	− 1
P	44	P	43	− 1
Q	39	Q	39	0
R	40	R	41	+ 1
S	24	S	24	0
T	40	T	41	+ 1
20	760		760	0
	1038		1038	

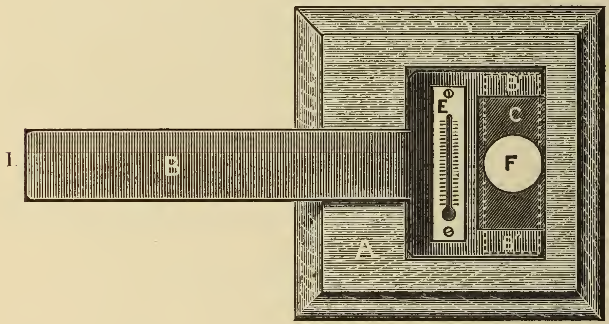
H H altered from 33 and 31 respectively.

An easily constructed Hot-stage.*—A very simple and convenient hot-stage was exhibited by Dr. Robert Reyburn at a recent meeting of

* Amer. Mon. Micr. Journ., xi. (1890) p. 1 (1 fig.).

the Washington Microscopical Society. This form is adapted from the more complicated and expensive forms used by microscopists, and is claimed to be especially useful from the fact that it can be made at a trifling cost by any one possessing a little mechanical skill. In fig. 56, A represents the wooden block or stage which is fastened upon the brass stage of the Microscope. A space is cut from the upper surface of this block, as shown by C, into which is fitted a piece of copper plate (B, B′, B″). A round hole is also cut at F, the opening of the brass stage, to allow of the illumination of the object to be examined. The slide is placed on the copper bed with its ends resting at B′ and B″, as indicated by the dotted lines. The heat is applied by a spirit-lamp at the end L of the copper plate B which

Fig. 56.



gradually transmits the heat by conduction to the slide. The temperature is registered by the thermometer E, which is screwed fast to the copper plate.

Application of Apertometer to the Microscope.*—Herr Kayser remarks that the narrowest perceptible distance of a wave-length stated by Fraunhofer and Nobert, is not the extreme limit which the newer Microscopes with oil-immersion systems have reached in the resolution of the structure of diatoms. The smallest recognizable distance ϵ approximates to the expression established theoretically by Helmholtz

$$\epsilon = \frac{\lambda}{2 \sin \alpha},$$

where λ denotes the wave-length and α the angle of divergence under which the extreme rays from the axis of the object fall upon the objective system. Since this angle can with an immersion lens be nearly a right angle, the numerical expression for the limit, taking $\lambda = 0 \cdot 00055$ mm. in the most general case, will amount to the half wave-length $0 \cdot 000275$ mm. According to the practical investigations of Abbe and Dippel, the resolving power of an objective system stands in very close relation to the magnitude of the angle of divergence. On this account makers are

* Schrift. der Naturforsch. Gesells. Danzig, vii. (1890) pp. xiii.–xvi.

obliged to have regard to the greatest possible angle of aperture or to the highest "numerical aperture" of Abbe, of which the expression is $a = n \sin u$ (where u is the refractive index). Accordingly they give in their price lists with dry systems the angle of aperture or the numerical aperture, and with immersion systems the latter. Whether these data correspond to the facts must be subjected to experiment. Herr Kayser received from a well-known firm an oil-immersion (1/16 in.), which he had required to be capable of resolving *Amphipleura pellucida* in oblique light. The system supplied did not answer to the requirements. The maker having ascribed the non-resolution to "badness of the preparation, defects in means of illumination, stand, &c.," it remained for a time doubtful whether these circumstances were really to blame. Herr Kayser was at that time engaged on the construction of apertometers. The apparatus resulting from his investigations, which serves for the examination of dry systems, has the following arrangement. Round a horizontal divided circle a vernier can be turned, and an upright, on which is fixed a Microscope directed horizontally, is set up in the centre. In front of the objective of the latter is a ring attached by a pin to the same upright. This ring can be rotated about the axis of the upright by means of side pieces which reach to the horizontal scale and carry a second vernier. With the plane of the ring at right angles to the axis of the Microscope, which passes through its centre, the reading on the second vernier is 90°, when the direction of the Microscope corresponds to the reading 0°. The system whose aperture is to be tested is placed in the ring. The Microscope is then displaced along its axis until the combined optical apparatus, which acts as a non-inverting telescope, shows the images distinctly. When by suitable turning of the whole apparatus the cross wires of the Microscope have been adjusted on an object not too near, the first vernier is displaced, without moving the second, both to right and left, until the image in each case just vanishes on the edge. The sum of the two angles read off is the angle of aperture. The angle thus given for an objective system, No. 7, of about 4 mm. focal length, was greater than the value given for it and found by the Abbe apertometer, in which the identity of an optician's systems of equal members is assumed. The author, attributing the magnification to his apparatus objective, tried the apertometer objective of Zeiss, specially made for the Abbe apertometer; but even with this the result remained unaffected.

The second apertometric apparatus constructed by Herr Kayser can be used for both dry and immersion systems. It consists simply of a glass plate of which one face is silvered and has scratched upon it a system of concentric circles which come into observation according to the dimensions of the apertures to be determined. The plate is laid on the stage with the silvered side downwards, and carries on its upper face in the middle of the rings, a small cover-glass, on the under side of which is a small mark. The Microscope containing the objective to be tested is first adjusted on this mark. Then without moving the body-tube the eye-piece is withdrawn, and again replaced in the tube when combined with the apertometer objective. The eye-piece is then adjusted so that the rings near the edge appear quite distinct; the extreme ring is counted, and if it does not exactly coincide with the edge, an estima-

tion in tenths of the following ring interval is made. A central portion of the silvering is removed and illumination by a mirror used in order to make the mark on the cover-glass visible. For the illumination of the rings, however, a white paper screen above the objective, and set obliquely to the incident light, is sufficient. The rings then appear dark on a white ground, and it is not necessary to have light incident from a mirror below. When an immersion system is to be tested, the observation is made in the same way except that, in this case, a drop of the liquid is first inserted between lens and cover-glass. To fix the diameter of the rings of this apparatus before they are actually scratched on the plate, a determination of the exact thickness of the glass plate and its refractive index must first be made. As found by the microscopical method, the first was 6·13 mm., the second = 1·525. The rings are arranged at intervals of 5/100 of the numerical aperture. The data, for example, for an aperture of 0·80 are as follows:—

$$0 \cdot 80 = 1 \cdot 525 \sin \chi,$$

whence the angle in the glass $\chi = 31° \, 38'$, but

$$\tan \chi = \frac{r}{6 \cdot 13},$$

from which is deduced the radius of the ring in question $r = 3 \cdot 777$.

The angle of divergence α in air, since

$$n \sin \chi = \sin \alpha$$

is

$$\alpha = 53° \, 7'.$$

The double amount 106° is therefore the angle of aperture corresponding to the numerical aperture 0·80 mm. The radii for the numerical apertures up to 1 would be as follows:—

0·80	3·777 mm.
0·85	4·115
0·90	4·481
0·95	4·881
1·00	5·324.

The plate contains in this way rings increasing in diameter up to the aperture

1·40	18·820 mm.

For greater distinctness, at certain intervals, two circles close together are drawn instead of one.

In testing the oil-immersion system previously referred to, the fifth reckoned from the ring corresponding to the aperture 0·80 fell on the edge of the field of view. It has, therefore, at most, the numerical aperture 1·00, whereas in the price list of the firm it was called 1·25. This was a great discrepancy, for if the system had really possessed the latter aperture, five more rings ought to have been seen. The numerical apertures necessary for the resolution of different diatoms are given in Dippel's text-book of general microscopy in the tables of comparison which have been established by exact scientific observations. On

reference to these tables, the data referring to 1·00 were found to be *Nitzschia curvula* and *Navicula rhomboides* (*Frustulia*) var. *saxonica* 36 striæ in 1/100 mm., while for the resolution of *Amphipleura pellucida* with 40–42 striæ, a system of 1·10–1·15 was found to be necessary.

Long before the use of the apertometric process, Herr Kayser had informed the maker of the system that he fixed the resolving power at 34 striæ from the fact that *Nitzschia curvula* was not resolved, and that *Frustulia* showed striæ first on the edges. The maker, ascribing the non-resolution to the mounting of the preparation, at the same time sent preparations which really were resolved. The striation of these, however, only amounted to 26 and 24 to 30 respectively, while *Amphipleura pellucida* was not forthcoming, because they were "at present not of good quality."

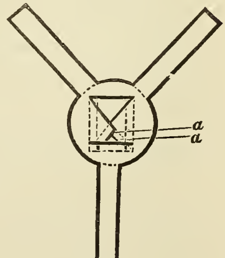
Dippel's work shows with what exactness the productions of microscopical forms can be apertometrically rated, in a way quite analogous to the determination of size by the scale. The action of an optician therefore who sells an objective system having a less aperture than it professes to have, must be compared to the behaviour of a tradesman who supplies goods deficient in quantity.

An advantage is now to be considered which the apertometer ring method possesses over that of Abbe. In the latter method a pointer is turned round on a polished glass cylinder until it appears to come on to the edge of the aperture. In this way the aperture is tested only in a certain diameter. By the author's method the whole range is seen at a glance, and any defects can also be noted. It is interesting that in the present dry system No. 7, the rings do not appear to be exactly concentric, but in a certain diametral direction on one edge there are broad intervals, on the opposite narrow ones, so that for the clear definition of the first, a further pressing in of the eye-piece is necessary. This asymmetry can be also recognized by the first method in the change in adjustment of the eye-piece, and out of the difference of the horizontal angle.

PLAXTON, J. W.—**A Camera Lucida for nothing.**

["The other day, after a morning's work, something went wrong with the prism of my camera lucida, and, do what I would, I could not bring it back to usefulness. At a loss for the moment, I cast about for a substitute, and in half-an-hour, with penknife and pencil, out of a piece of stiff paper and a square of thin glass, had turned out a fragile but efficient substitute for what is known in catalogues as 'Beale's Neutral Glass Reflector,' price 6*s*.

FIG. 57.



"This is how I did it—Describe a circle by standing the eye-piece of the Microscope on the paper and running a pencil round it; inscribe a square in the circle already drawn by drawing the pencil along the edges of the square of thin glass you intend to use; now lay down the diagonals of the square; draw three other lines within the square, each one parallel with a side of the square, and each, say 1/8 inch from the side; draw two other short lines (*a a* in the diagram, fig. 57) parallel to the diagonals.

Take the penknife and, following the continuous lines of the diagram, cut through the paper: you will have in paper what resembles a three-spoked

wheel without tire. The upper triangle of the four within the square falls away as useless; the lateral triangles open outwards, and stand at right angles with the plane of the circle; the little flanges on their lower edges are made by creasing the paper to support the thin glass. The base of the lower triangle answers the same purpose.

"Put the eye-piece in the Microscope, the circle of paper to the end of it; turn the spokes of the wheel back along the tube, and slip a tiny elastic band over them, or tie them with a thread; a little manipulation with the fingers, the thin glass is in place, and the thing is done.

"Need I say that any one can see that it would be almost as easy to use a piece of thin sheet brass or other metal as to use paper?"]

Journ. of Microscopy, III. (1890) pp. 40–1 (1 fig.).

(4) Photomicrography.

Some Experiences in Photomicrography.*—"More than a dozen years have now elapsed since I made my first photomicrograph; at that time the successful workers in this country could be counted on one's fingers, and the old messy wet process and expensive appliances were regarded as indispensable for good results. The development of amateur photography following the general introduction of dry plates could not fail to influence photomicrography, since few microscopists viewed with indifference the placing at their doors of a ready means of recording observations. The experience gained during ten years of continuous work, covering almost every class of subjects, with amplifications ranging from four to four thousand diameters, has, naturally, emphasized many facts; the possibility that a brief statement of these conclusions may aid younger workers in this field must be my apology for the egotism of these remarks.

While appreciating fully and endorsing heartily the efforts of those working with no greater responsibility than their individual enjoyment, it is rather to those seriously engaged in endeavouring to produce the best and highest class of this work, that these suggestions are offered.

The three essential conditions for success in photomicrography are:—(1) Satisfactory apparatus; (2) Good illumination; (3) Suitable preparations.

Satisfactory apparatus by no means implies elegant appliances, but adaptation to purpose; so that the Microscope be very solid and firm, and supplied with a substage to which a condenser can be attached and satisfactorily adjusted, and that the camera be of sufficient length, it matters little as to exact form or detail; for high powers the mechanical stage is a convenience, and for extreme amplifications (2000 and over) well nigh a necessity. The most complete photomicrographical outfit to be had is, undoubtedly, the one made by Zeiss, of Jena. . . . Of greater importance, however, is the quality of the objectives, for only those of the most perfect correction will stand the severe test of photography. While there are many others, which personal use has shown to answer well, my experience would lead me to select the following as being especially satisfactory:—3 in. Crouch, $1\frac{1}{2}$ in. Beck, 3/4 in. Bausch and Lomb, 4/10 in. (BB) Zeiss, 1/4 in. "Photographical" Bausch and Lomb, 1/6 in. (DD) Zeiss, 1/12 in. oil-immersion apochromatic Zeiss. The 3 in. Crouch and the 4/10 in. (BB) Zeiss deserve especial mention,

* By George A. Piersol, M.D., of Philadelphia. Amer. Annual of Photography, 1890.

as for crisp definition over an entire perfectly flat field they are unsurpassed; for high amplifications the new apochromatic oil 1/12 Zeiss is superb.

The question, whether to receive the image directly from the objective on the plate, or to employ some means to project the image, has received of late much attention. While fully appreciating the theoretical objections to the direct image, I confess that for low and medium powers I continue to use it by preference, as the photographs so obtained fully equal in every respect any which I have ever seen made by the indirect mode. With high amplifications (1000 diameters and over), the conditions are greatly changed by the approach to the limit both of the shortness of the focus of the objective and of the length of camera which can be advantageously used; my experience leads me to adopt the 1/12 in. objective as the one, and not over four feet as the other limit, since any given high amplification, say 2000 diameters, can be more satisfactorily and more conveniently obtained with a superior 1/12 in. connection with suitable optical means to increase the initial magnifying power of the objective than with an unaided 1/25 lens and the plate removed to a great distance. Until quite recently the various amplifiers offered the best means of increasing the power of an objective, but the introduction of the "projection-oculars" of Zeiss has given us an accessory for this purpose far superior to the older devices. These projection-oculars resemble the ordinary microscopical oculars, or eye-pieces, only in general form and in name, being optically a projection-objective in connection with a collecting lens. The new oil-immersion apochromatic lenses, in combination with these projection-oculars, form, undoubtedly, the most efficient equipment for high-power work, and have but one drawback—their cost. It is, unfortunately, as true for high-power photography as for microscopical observation in general, that the best results are to be obtained only with fine, and necessarily expensive, optical appliances. If for the satisfactory study of the intimate structure of a cell, or of a micro-organism, the most improved immersion lenses are necessary, it is to be expected that for the successful photographing of the same, tools at least as good are needed. The complicated mechanical arrangement for controlling the focusing adjustments from a distance, may usually be replaced with advantage by the simple contrivance of cords and weights, devised by the writer more than a dozen years ago, which has been so generally adopted in this country; during the extended continued use of this little device, it has never been found wanting, responding perfectly to the severe demands of the highest amplifications. A modification for the coarse-adjustment, having pulleys and very heavy weights, serves equally well when very low (2 to 5 in.) lenses are used. A very stiff spring in the fine-adjustment may sometimes require increased friction to prevent the cord from slipping, the necessary traction being obtained by heavier weights, or by taking an extra turn of the cord about the milled head of the micrometer screw.

My conclusions regarding the second of the necessary conditions—good illumination—are briefly stated; after many experiments with various kinds of artificial illumination, and after the examination of innumerable specimens of the best work of acknowledged experts, while, of course, admitting that good photographs can be made, under suitable

conditions, by these means, yet I am fully pursuaded that sunlight is by all odds the best, and, for high powers, the only really satisfactory illumination by which to make photomicrographs that are satisfactory as photographs, as well as records of microscopical observations. That even by good lamplight fair impressions of objects under extreme magnification can be obtained, no one questions, but the negatives produced by such illumination seldom, if ever, possess the characteristics of a really good sunlight negative, where the sharpest details are combined with an exquisite softness and harmony of half-tones. That a photomicrograph should be a silhouette of deep shadows and chalky whites, is a proposition to which I could never subscribe. Sharpness and vigour are, of course, the first essentials in a photomicrograph, but there seems to be no reason that in such a picture all the qualities of a good photograph should not be represented. An almost identical opinion regarding the advantages of sunlight, has been reached by Dr. R. Zeiss,* after a most exhaustive series of experiments with artificial illuminations of all kinds, stimulated by the hope of finding a satisfactory substitute for sunlight, the uncertainty of which, during the greater part of the year, is even a greater inconvenience in Germany than with us.

The third condition for good work—suitable preparations—though last, is by no means least, for all apparatus and illumination avail but little when proper preparations are wanting. Thanks to our present microscopical technique, these are readily obtained, since extremely thin and well-stained preparations of vegetal and animal tissues are now matters of everyday production. The thinness with which sections are now usually cut (·005–·01 mm.) often renders them, when stained with the staple carmine dyes, too actinically transparent to photograph well with very low powers. The interposition of some ray-filter readily overcomes this; during the last three years a screen of yellowish-green glass has been in constant use, with the most satisfactory results, yielding plucky pictures of objects entirely too transparent to produce sufficient contrasts in the negatives; the exposure, however, is increased about three to five times, but this, even when thus lengthened, seldom exceeds 20–25 seconds, on Carbutt's "B 12" plates. Where great differences of colour are present in the same preparation, or where certain unfavourable tints, as deep brown, prevail, the orthochromatic plates offer decided advantages; for, however, ordinary preparations with but one stain, the colour-screens, when judiciously selected, will yield equally good pictures, with a gain in economy, convenience, and certainty. The modified hæmatoxylin stains, producing browns and slate-blues, are very valuable for special purposes, but require some considerable technical experience for their successful production.

What has been written may appear to discourage the undertaking of this most fascinating branch of photography, where the primary object of instructive entertainment does not warrant the acquisition of the class of appliances above recommended; this should not be so, as the full force of these suggestions applies only to those whose work in this line necessitates the use of the higher amplifications, with the view of producing the highest possible results."

* 'Special-Catalog über Apparate für Mikrophotographie,' Jena, 1888.

To the amateur, who has been using but lamplight for his exposures, it is suggested that he avail himself of some bright "off-day" to give sunlight a trial. If the mirror of the Microscope be of good size, it will be only necessary to make an arm on which to support the removed mirror outside some southerly exposed window, since it is desirable to have much more distance between the mirror and the stage than would be possible were the mirror attached in its usual place. Where the Microscope mirror is too small to be satisfactorily used, a rectangular wood-framed looking-glass is readily mounted with the aid of a few strips of wood, so as to turn about both axes.

The rays from the plane side of the mirror are passed through a condensing lens (of 8–10 in. focus, if possible), so placed that they are brought to a focus before reaching the plane of the object. The exact position of the condensing lens is a matter of experience; usually, however, the most favourable illumination is obtained at that point where the field is still *uniformly* illuminated, just before the rays form an image of the source of light; the nearer the rays are focused, the less disturbance from diffraction rings. Ordinary objectives will require the employment of monochromatic light—produced either by a deep blue solution of ammonio-sulphate of copper, or by the green glass screen already mentioned—since the optical and actinic foci do not usually coincide. Powers up to the 3/4 in. will require no further condenser; with the 1/4 or 1/6 objectives, the low power (1 or 3/4 in.) serves with advantage as an achromatic condenser, when attached to the substage. The Abbe condenser, although so important for refined microscopical investigation, is not adapted to photography unless a very wide cone of light is desired, which, for the majority of preparations, is a decided disadvantage; a low-power objective, used as a condenser, will generally be found more satisfactory than the Abbe with a small diaphragm.

The simple apparatus indicated, when properly handled, will produce excellent work with such powers as the amateur is likely to employ; focusing the image by the monochromatic light, and avoiding over-exposure, being the points especially requiring experience. When it is remembered that seconds, with very slow plates, usually suffice for the minutes with rapid ones of an exposure by lamplight, the intensity of the actinic power of the sunlight will be somewhat appreciated. Some simple arrangement, by which the rays from the mirror may be cut off with sufficient rapidity, will suggest itself; an effective one is a small shutter, turning at one end on a screw and covering a circular opening in a board, through which the rays from the mirror pass; the rapidity with which the sun's image from a fixed mirror becomes decentered necessitates a readjustment of the light just before each exposure, but the patience thus exercised will be more than repaid in the character of the resulting negatives.

Microphotographs of Wood Sections.—An interesting communication on this subject was recently made by MM. Thil and Thouronde to the French Photographic Society. Microphotographs to the number of about four hundred were executed to the order of the Minister of Agriculture. M. Thil, Inspector of Government Forests, has, in very precise language, pointed out the reach of this application of photography, which permits of the classification of woods in families

and species, thanks to the comparison alone of the intimate structure of the fibres and cellular network. By this means we are enabled, with the help of simply thin cuttings, to give, so to say, a complete anatomy of each species, and to notice easily the essential differences which exist between woods of different species, although belonging to the same family; all the more, therefore, can we recognize classification in families. Microphotographic pictures, projected by the lantern, served to demonstrate clearly the truth of the propositions affirmed. This is a new example of the numerous services that photography may render to the sciences.

The Coloured Screen in Photomicrography.*—The following is an abstract of a paper by Professor Romyn Hitchcock:—

An ordinary gelatino-bromide plate is sensitive to the spectrum of sunlight from a point between the Fraunhofer lines E and F to about K. The maximum photographic action is about G. By considerably prolonging the time of exposure the limit of photographic action at the red end of the spectrum is greatly extended. In practice the light below the green of the spectrum may be regarded as quite inactive when we take photographs with ordinary plates.

By introducing a coloured screen—a plate of yellow glass for example—in the path of the light, we may absorb the more active rays, and prolong the time of exposure until the yellow rays have time to act upon the sensitive plate. In practice, however, it is found that there are two difficulties about this method of procedure; first, in obtaining a satisfactory screen, and second, in the long exposure necessary when working with the comparatively inactive rays.

With colour-sensitive plates, such as are now in general use abroad and gradually being introduced in this country, the range of photographic action towards the red is greatly extended. With such plates the yellow screen can be used with great advantage.

A few years since it was customary to work with monochromatic blue light in photomicrography, and the ammonio-sulphate of copper blue cell was much in use. When colour-sensitive plates were introduced yellow screens took the place of blue, because it was found that many specimens had yellow and red and brown parts which were not well photographed with blue light.

The colour and thickness of the screen both require attention. If it be too thin the blue light is not sufficiently cut off. In particular cases an almost monochromatic yellow light is desirable, as when it is desired to obtain sharp outlines of deeply stained objects regardless of structural details. But generally a rather broader spectrum range is desirable, for the light employed should correspond to the different colours or shades of colour of the object. It is owing to neglect of this consideration that we often see photomicrographs which are mere silhouettes, while the objects show much more structure to the eye. This is frequently observed in photographs of such structures as the tongue and sting of a bee, and legs of insects. In other preparations, in which the colour is a stain, brown or red for example, the fault lies partly in the exposure, which, in many cases, is insufficient to give more than

* Amer. Mon. Micr. Journ., xi. (1890) p. 8.

outlines and blank interiors. This is frequently noticeable in photographs of bacteria.

By a proper choice of a screen, if a screen is required, a photograph should show any object as clearly as we can see it in the Microscope.

Colour-sensitive plates may be said to be indispensable in the photography of rock-sections with polarized light.

The yellow solution devised by Professor Zettnow, of Berlin, is used with much favour by many workers. It is composed as follows:—Copper sulphate, 175 grm.; potassic bichromate, 17 grm.; water, 1000 ccm.

The true function of the colour-screen should be to give definition and detail, not to increase contrast between the object and the field, as many observers seem to believe.

(5) Microscopical Optics and Manipulation.

Amplification in Micrometry.*—My attention has quite recently been drawn to this subject in connection with the celebrated Dr. Cronin case. It may be taken for granted that one cannot measure what he cannot see. But how high an amplification is necessary in a given case is a matter of much importance. In the measurement of blood-corpuscles in medico-legal cases the late Dr. Richardson advocated the use of a very high power, viz. a 1/25 or 1/50 objective. In my own measurements of blood-corpuscles I have, out of respect to authority, always used a high power, from 1500 to 1800 diameters. Recent experience has, however, qualified my views upon the subject, and in the case of the comparison of the ultimate subdivisions of a micrometer, ruled on metal, I am now of opinion that practically the same result may be obtained by the use of a 1/4 objective as with a 1/18 or 1/25.

In December 1885, I commenced the investigation of the 1/100 mm. spaces of "Centimeter A"; but was unable to finish it. Two series of measurements were then made with a Bausch and Lomb opaque illuminating objective, and a Bulloch filar micrometer. Recently I have measured the same spaces with a Spencer 1/10 and 1/25, and with a Zeiss 1/18. The results of these measurements are given in the table below, each correction being the mean of from three to twelve readings of the filar micrometer at each end of the measured space.

It will be observed that the agreement between the several series of the writer, and the results obtained by Prof. Hilgard is quite close, the discrepancy being practically insensible.

Provided the amplification is sufficient to render the object to be measured of a sensible size, and to render the difference between the sizes of two objects visible, my own judgment is that little, if anything, is gained by the use of a power so high as to impair the definition, even though such impairment be but slight. Quite as much, in other words, is lost by impairment of definition as is gained by increase of amplification. The practical conclusion then is that no higher power should be used than is consistent with perfect definition.

Diffraction Rings and Diffraction Spectra.—There appears to be still some confusion between the diffraction "spectra" of the Abbe theory and the diffraction bands or fringes and spurious lines seen

* By Hon. Marshall D. Ewell, LL.D.

surrounding the outlines of all objects in the field of the Microscope, when the illumination is obtained by somewhat narrow but sufficiently bright beams of light, especially with high powers or deep eye-pieces.

The latter are true diffraction bands, originating from the diffraction of the light at the object, but the difference between the two phenomena is that the spectra represent the diffraction effect of the object at a very distant plane, conjugate to the posterior focus of the objective, whilst the "bands" or "fringes" show the diffraction effect of the same objects in a plane close by, i. e. in the neighbourhood of the objects themselves. Nägeli and Schwendener, it is true, deny that these fringes are diffraction phenomena, and explain them as interference phenomena in a somewhat complicated manner, but Prof. Abbe considers that he has established the incorrectness of their views on this point, except so far as they assert that the phenomena cannot be due to the diffraction effect of the lens opening, as had previously been assumed by Helmholtz and others.

(6) Miscellaneous.

The 300th Jubilee of the Microscope.*—"B. C." writes:—Natural science enters this year on a memorable anniversary, the 300th Jubilee of the Microscope, one of the most powerful of its resources. To this instrument is due in great measure the wonderful impulse given to science in the second half of this century. The importance to which the Microscope has attained in scientific investigations is well known. It has become an absolutely indispensable instrument to the zoologist and botanist, to the mineralogist and geologist, to the astronomer and the physician. The Microscope has effected a complete revolution, and has diverted the direction of study into the most varied channels. In fact it has created a new method of research, such as histology. On the healing art the Microscope has exercised a most beneficent influence; for while it explained the changes undergone by the finest tissues in the various diseases—it was on microscopic observation alone that Virchow founded his renowned system of cellular pathology—it pointed out at the same time the means of healing them. The Microscope has also been of wonderful service in technical matters. Before attaining its present high degree of perfection, the Microscope had to pass through a number of intermediate stages which it is of great interest to look back upon on this its 300th jubilee. . . .

It is strange how slowly the Microscope found its way into learned circles. It was only when Leeuwenhoek had by its aid discovered the infusoria that it became generally used in the scientific investigations of anatomists and physiologists. What it has accomplished since that time constitutes the glory of the natural sciences. The Microscope soon passed from the workshops of the spectacle-makers to those of the optician, by whose skill it has undergone, little by little, numerous changes, corrections, and improvements. Not to mention all of these, it will suffice to point out the arrangement of the transmitted light (1685), of the reflecting illuminating mirror (1715), and the use of achromatic and aplanatic objective lenses (1824). In more recent times the Microscope has received further improvements, which have cast into the shade all conceivable expectation; and unless appearances deceive us the finer

* Central-Ztg. f. Optik u. Mechanik, xi. (1890) pp. 69–70.

mechanics of Microscope construction have not yet reached the limit of their capabilities. The latest acquisition of medical science, the bacteria, has put the greatest demands on the Microscope, and reveals to this instrument the deepest secrets of nature. Let it be the aim of science to gather in a still richer harvest by the aid of the Microscope!

The Microscope banished.—The following appears in the *Daily News* of the 9th April:—"An interesting paper by Mr. Bothamley in *The Photographic Quarterly* reminds us of the important part now played in education by the optical lantern which in the memory of so many among us was a mere toy for the entertainment of juvenile parties. The initiation and growth of the system is mainly due to Professor Miall, of the Yorkshire College, Leeds, in which important institution almost every department has its lantern, and such widely different subjects as biology and engineering, ancient history and textile industries are alike illustrated by this convenient means. In the biology lectures *the lantern is said to have well nigh banished the Microscope, thereby effecting a great saving both in cost and time* (!) The production of lantern slides is found to be most easily and rapidly done by photography. Original objects, drawings, large photographs, illustrations in text-books, can all be reproduced in the same way. At the Yorkshire College the number of slides required by the various departments is stated to be so large that the whole time of a special photographic assistant is occupied with their production, although the work is much facilitated by the ingenious copying camera devised by Professors Barr and Stroud. But perhaps the most remarkable fact in connection with this subject is Professor Miall's discovery of how the lantern may be used in illustrating lectures in a room illuminated by daylight."

Miss V. A. Latham, F.R.M.S.* — This lady has recently been elected to the chair of Demonstrator in Pathology in the University of Michigan. Professor Latham is the first lady who has held any office in the Medical Department of the University, and has our congratulations and best wishes for her success.

β. Technique.†

BÖHM, A., U. A. OPPEL.—**Taschenbuch der mikroskopischen Technik.** (Handbook of microscopical technique.)
München (Oldenbourg), 1890, sm. 8vo, 155 pp.

GORONOWITSCH, —.—**Kurze Uebersicht über die Fortschritte in der mikroskopischen Technik im Jahre 1888.** (Short review of the progress in microscopical technique in 1888.) *Medizinsk. Oboscrenije*, 1889, No. 8 (Russian).

KAHLDEN, C. VON.—**Technik der histologischen Untersuchung pathologisch-anatomischer Präparate.** Für Studirende und Aerzte. Ergänzungsheft zu Dr. E. Ziegler's Lehrbuch der allgemeinen und speciellen pathologischen Anatomie. (Technique of the histological examination of pathological-anatomical preparations. A supplement to Dr. E. Ziegler's Handbook for the use of Students and Physicians.) 6th ed., Jena (Fischer), 1889.

POLI, A.—**Note di microtecnica.** (Notes on microtechnique.)
Malpighia, III. (1889) June, August, December.

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* Amer. Mon. Micr. Journ., xi. (1890) p. 10.

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

(1) Collecting Objects, including Culture Processes.

Procuring and Preparing Protista found in the Stomachs of Ruminants.*—To obtain Protista from the stomachs of oxen, says Dr. A. Fiorentini, it is merely necessary to open that viscus with a knife, and gather some of the gastric juice in test-tubes. In order to keep the animals alive it is advisable to keep the tubes immersed in water at a temperature of 30°–35°. To examine these Protozoa alive, it is necessary to make use of Schultze's or Ranvier's hot-stage, so that the slide may be kept at 35°. But the following method has the advantage of simplicity. Heat the slide over a spirit-lamp until it becomes warm. Then place thereon a drop of the fluid containing the animals to be examined, and cover with the cover-glass. Next with a pipette take some boiling water and drop it in lines on the slide, taking care, however, that it does not mix with the fluid under the cover-glass. This device will keep the preparation warm sufficiently long to examine the Protozoa alive. When cold a new preparation must be made.

For fixing the animals, the author used a 1 per cent. osmic, and for staining the nuclei and nucleoli fuchsin, alum-carmine, and alum-cochineal. Glycerin and Canada balsam were used for clearing up the preparations when osmic acid had blackened them or made them obscure.

Useful Collecting Device.†—Mr. J. Walker finding his collecting bottle, a modified Wright, somewhat cumbersome, "decided to use a smaller bottle, and have the strainer (I use bolting silk 10,000 to the inch) outside instead of inside. I therefore procured a bottle holding about 4 oz. A square bottle with a wide mouth is preferable, though a round one will answer well. I bored four holes opposite each other, 1 in. above the bottom and about 3/8 in. in diameter, and enlarged the openings in a direction parallel with the length of the bottle, until within an inch of the neck. Over these four oblong apertures I cemented fine bolting silk or other desirable material with shellac, and when dry, the bottle was ready for use. To those not having the tools needed for drilling glass, I would recommend a small tin can or box, such as that in which Colman's mustard is sold, or the common round pepper-box obtainable from the grocery stores, the lid making a good coarse strainer.

In working with it, the currents of water passing through the meshes of the strainer will cause fine debris to collect on the inside, which in this case is easily kept clean with a small brush, a piece of wood, or a stalk of grass. The concentrated material will be found at the bottom of the vessel, and can be transferred to another small bottle carried for the purpose."

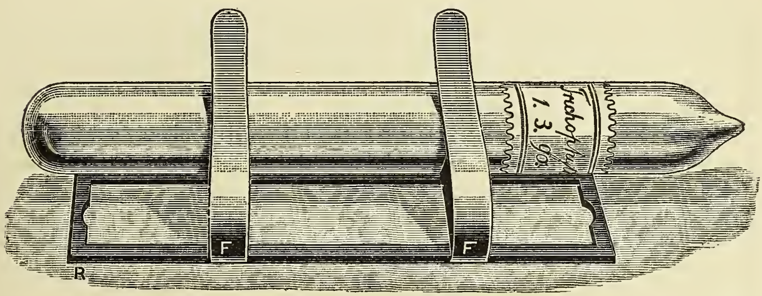
Collecting-bottle for Rotifers.‡—Mr. A. Pell remarks, "Here is the 'boss' collecting implement at last. Take one of the new lard bottles which hold a quart, the mouth being about 4 in. across, with a metal cover that screws to the neck, and a handle by which it is readily carried. Make a tube of muslin or of linen, in any desirable

* Journ. de Micrographie, xiv. (1890) pp. 15–6.
† The Microscope, ix. (1889) pp. 372–4.
‡ Op. c., x. (1890) p. 151.

fineness, and about 2 feet long, 4 in. in diameter at one end, and 2 at the other. Fasten a tin ring to the small end and attach the large end to the mouth of the bottle. Then put on your rubber boots and go to the pond. There pour the water into the small end of the muslin tube, holding it up for that purpose, the bottle hanging below. It will rapidly strain out the Rotifers, &c., which will finally get down into the bottle, and as the muslin tube has so large a surface the water will run through quickly, all solid matters collecting in the bottle. Less is lost by the use of the muslin tube than by a funnel-shaped strainer, and the cloth will not become clogged."

Test-tube Holder for Microscopical Investigations.*—Dr. D. von Sehlen has invented a test-tube holder, the advantages of which are mainly its stability and simplicity. Hence it will be found of great use in the cultivation of the various forms of Fungi, and also for photo-

FIG. 58.



graphic purposes. The apparatus consists of a flat oblong frame R which supports two uprights, placed equidistant from the ends of the frame. In these uprights a triangular piece is cut out in order to put the test-tube in, and the latter is kept in position by the two spring-clamps F. The distance between the two spring-clamps is enough to allow sufficient space for the objective to work in, and the length of the frame such that it is easily clamped to the Microscope-stage. It is hardly necessary to explain that the test-tube is easily moved round its short axis, and pushed up and down, so that when on the Microscope-stage it is easily illuminated from below.

Preparation of Nutritive Agar.†—Dr. V. A. Moore writes:—"The extent to which nutritive agar is employed in the cultivation of Bacteria renders it of much importance that its method of preparation should be made as perfect as possible. When it is prepared after the method recommended in works on bacteriology (which is practically the same as that first formulated by Koch for the preparation of solid culture media), a medium is obtained that favours the growth of most germs. In this respect the method is desirable, but in regard to the other

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 17–20 (2 figs.)

† Amer. Mon. Micr. Journ., xi. (1890) pp. 115–7.

requisites of a satisfactory solid medium it is quite deficient. The objections to the method with reference both to the process itself and the character of the resultant agar are three in number. (1) The difficulties attending the filtration of the agar. This process alone often requires a very considerable length of time besides the use of a hot filtering apparatus that must be provided especially for this purpose. (2) The presence in the sterile agar of a flocculent precipitate that is invariably thrown down during the process of its sterilization, and which greatly interferes with its usefulness, especially in making roll and plate cultures. (3) The variation in the consistency of the agar. It is impossible to obtain this material of the same consistency, as the agar is only partially dissolved, even after long boiling, in the simple beef-infusion. The coagulation of the albumen ensheaths the stems of agar, floats them to the surface where they remain imbedded in the firm, albuminous coagulum. This property of the agar is worthy of consideration, for with the varying consistency of the medium a consequent change follows in the character of the growth of most germs.

For the purpose of securing a process for the preparation of nutritive agar that was free from the above mentioned difficulties I have reviewed carefully the method of Jacobi,* Von Freudenreich,† and Cheesman,‡ in all of which I found difficulties that were equally as objectionable as those possessed by the original method.

The use of a solution of beef-extract in distilled water, instead of the simple beef-infusion made directly from the fresh meat, was also tried, but the agar thus prepared did not favour as vigorous a growth of many germs as when prepared from the fresh meat-infusion. So feeble was the growth of many germs upon this agar that the method was abandoned, although very satisfactory in other respects.

In the course of this experimental work it was found that when the stems of agar were cut into small pieces and boiled in a fluid containing no coagulate material, that it was entirely broken up and the soluble portion dissolved. The insoluble particles that remained suspended in the liquid were easily and completely removed by the addition of egg albumen, and subsequent boiling and filtering. From these facts a method for the preparation of nutritive agar was derived, which consists in first preparing the neutralized beef-infusion-peptone, and thus getting rid of all coagulable material before the agar is added. This process is effective in greatly diminishing the time and attention required for the preparation of this medium. The medium can always be made of the same consistency, as all of the agar that is added is dissolved. It remains free from precipitates when sterilized, and its nutritive qualities are as favourable to bacterial growth as when it is prepared after the original method.

(1) *The preparation of the beef-infusion-peptone.*—The method of preparing this liquid is practically the same as that already in use in most laboratories. Finely chopped or ground beef (freed from fat) is macerated in distilled water for from 12 to 18 hours in a cool place. The distilled water is added in the proportion of 200 ccm. to each

* Centralbl. f. Bacteriol. u. Parasitenk., iii. (1888) p. 538. † T. c., p. 797.
‡ American Naturalist, xxii. (1888) p. 472.

100 grams of beef. On the following day the liquid is separated from the meat by straining it through a coarse linen. The simple beef-infusion thus obtained should be equal in quantity to the amount of water added; if it is not the deficiency can be restored by the addition of distilled water. To the beef-infusion is added 1 per cent. peptone, 1/2 per cent. sodium chloride; and if it is desirable to make it alkaline, a sufficient quantity of a normal solution of sodium carbonate to give it a weak alkaline reaction. The liquid is then boiled for thirty minutes in a water-bath, cooled, filtered, and distributed in Erlenmeyer flasks plugged with cotton-wool. If only a small quantity of agar is to be made at once, 250 ccm. is found to be a very convenient quantity to put in each flask. It is then sterilized by boiling for one hour each day for three consecutive days. It need not be sterilized if it is desirable to prepare the agar at once. As the beef-infusion-peptone is also employed as a liquid medium in the cultivation of bacteria, very little time is lost in preparing an extra quantity of this liquid to be used in making the agar.

(2) *The preparation of the agar.*—To an Erlenmeyer flask (a glass beaker or agate or iron vessel may be used) containing beef-infusion-peptone, as prepared above, 1 per cent. of *very finely chopped* agar is added. The flask is then placed in a water-bath and boiled vigorously for two hours. At the end of that time the agar is dissolved, and the liquid is allowed to cool. When a temperature of 40–45° C. is reached, the white of egg is added in the proportion of one egg to 250 ccm. of the liquid. After the albumen is *thoroughly* mixed with the liquid agar it is returned to the water-bath and again boiled for two hours. It is of much importance that the albumen is evenly distributed throughout the mass before it is coagulated. It is now ready to be filtered. The egg albumen is coagulated in very firm masses, leaving the liquid perfectly clear. The coagulum is removed by filtering the liquid through fine Japanese filter-paper or a layer of absorbent cotton, as a 1 per cent. solution of the agar does not pass readily through ordinary filter-paper. Should a weaker solution of the agar (1/2 to 3/4 per cent.) be desired, its filtration can be accomplished by the ordinary method. A hot filtering apparatus is not necessary. The clear filtration is now ready for distribution in sterile cotton-plugged tubes.

The agar is sterilized by discontinuous boiling in a closed water-bath for three consecutive days. If small tubes have been used containing not more than 7 ccm. each, five minutes' boiling each day is sufficient. If larger tubes are used, they should be boiled for a longer time. Or it may be sterilized by steaming each day for from five to ten minutes after the agar has become liquefied for the same number of days. After its sterility has been tested by allowing it to stand in an incubator for several days, it is ready to be stored until required for use. It has been customary in this laboratory, in order to prevent the evaporation of the agar by long standing, to dip the lower end of the cotton-plugs in hot sterilized paraffin, and to store the tubes in a cool, moist chamber."

(2) Preparing Objects.

Preparation of Crustacea.*—Dr. O. vom Rath gives an account of the method he adopted in his investigation into the structure of the Cymothoid Crustacean *Anilocra mediterranea.* The heads were cut off with a sharp pair of scissors and immediately placed in picric-nitric acid, picric-sulphuric acid, warmed absolute alcohol or chrom-osmic-acetic acid; the first of these reagents gives especially good results. The hardened heads were stained *in toto* in alum-carmine or borax-carmine. Paul Meyer was quite right in urging that the mere preservation in alcohol of Crustacea or other Arthropods with a strong chitinous membrane is quite insufficient.

Modes of Studying Segmental Organs of Hirudinea.†—M. H. Bolsius did not learn much by dissecting out the segmental organs and mounting them entire. It is better to cut sections of the entire animal, or, when it is large, of parts. Transverse, vertical, longitudinal, or horizontal longitudinal sections should be made. To prevent contraction of the body, large specimens should be anæsthetized before being killed. Small specimens should be placed in a 1 per cent. (or even weaker) solution of chromic acid. Passable results in the way of fixation were obtained by bichromate of potash, but bichloride of mercury is much more efficient. A saturated aqueous solution or Gilson's liquid may be used. In either case small individuals are placed in them for 15 to 30 minutes; larger pieces must remain a proportionately longer time. Excellent preparations were also obtained with a 2 per cent. solution of nitrate of silver; in this case staining reagents were not used, but with the others a picro-alum-carmine, the formula for which has not yet been published, but which is used at Louvain, was found to give excellent results.

Mode of Investigating Hydra fusca.‡—Herr K. C. Schneider recognizes that it is only possible to study the nervous system of Hydroids by maceration-processes. It is scarcely possible to recognize in sections the cell-boundaries of the ectoderm, to say nothing of distinguishing them from the separate subepithelial elements. The structure of the cells is considerably affected by the use of paraffin. As a maceration-medium, the author first used pure acetic acid from 1 to 10 per cent; but as this caused deformation of the elements, chloride of sodium was used, and was followed by various strengths and quantities of osmic acid. After some experiments, a mixture of one part 0·02 per cent. osmic acid with four parts 5 per cent. acetic acid was found to give excellent results. Pure osmic acid was found to give very different results from the mixture of osmic and acetic acids. Animals placed for eight days or more in glycerin were very useful in the study of the nervous system. Picrocarmine was found to be the best staining medium, but Beale's carmine and safranin were also of use.

Microscopical Sections of Tooth and Bone.§—It was with great satisfaction that we read Mr. J. Howard Mummery's notes on the prepa-

* Zool. Anzeig., xiii. (1890) p. 232. † La Cellule, iv. (1890) pp. 374–6.
‡ Arch. f. Mikr. Anat., xxxv. (1890) pp. 322–3.
§ Trans. Odontol. Soc. Great Britain, xxii. (1890) p. 207.

ration of microscopical sections of tooth and bone, in which he gives an account of some new and important discoveries in the structure of these tissues, for it was from this Journal,* he tells us, that he obtained an account of Dr. L. A. Weil's method of carrying out the balsam process. "I prepared," says Mr. Mummery, "some sections according to these directions, and was so pleased with the results that I have since cut nearly two hundred specimens in this way." It should not be forgotten that this portion of the Journal is of great assistance to those who, like Mr. Mummery, have little time for searching the literature of microscopical technique.

Preparing Sections of Teeth.† — Mr. W. A. Hopewell-Smith remarks:—

"(1) The most satisfactory method, in my opinion, of preparing sections showing odontoblasts *in situ* is as follows:—The jaw, preferably the lower, of an embryonic mammal, such as kitten or pup, taken while still in a fresh condition, is carefully stripped of all the tissues covering it, except the oral epithelium and flange of gum, and is placed in the usual standardized solution of Müller's fluid, in order to harden its soft structures, the volume of fluid being about twenty or thirty times the bulk of the immersed tissue. The fluid must be changed every day for four or five days, and then every third or fourth day. The hardening process is to be completed by removing the specimen—which has remained in the Müller's for a fortnight—to alcohol or rectified spirit; and this is to be renewed occasionally until all the colouring matter has disappeared from the specimen and fluid. Vertical sections are then cut by means of a thin sharp knife, and these placed longitudinally on the stage of a Cathcart or Williams freezing microtome, and cut in the ordinary way. Best results are obtained from sections in the canine and bicuspid regions, as here the parts are less likely to be disturbed in the manipulations with the microtome. Imbedding in paraffin and wax, or celluloidin, is of little service. The advantages claimed for this method are:—(*a*) The simplicity of its performance. It will be seen that the hard tissues are not softened by any decalcifying agent, which would materially affect the delicate soft tissues. The knife cuts quite easily the thin cap of semi-calcified dentine and bone, and the elements of the pulp are in no way disturbed in their relation to each other. (*b*) The odontoblasts are of large size, and easily observable at this period, as their formation of dentinal fibrils is at its highest stage of development. They can be isolated, if thought necessary, by separating with the point of a needle from the surface of the dentine papilla the cap of dentine to which in places they adhere. (*c*) This method affects little, if at all, the relative positions of dentine, odontoblasts and pulp; and I have found it to be extremely successful.

(2) I should advise your correspondent not to grind down sections of teeth of fishes *in situ*; but to decalcify the jaw and teeth with a 5 per cent. solution of chromic acid or 10 per cent. solution of HCl. After sections have been cut and stained they should be washed well in distilled water, dehydrated for three minutes in absolute alcohol, "cleared" in oil of cloves or xanthol, and mounted in Canada balsam.

* 1888, p. 1042.

† Journ. Brit. Dental. Assoc., xi. (1890) pp. 310–2.

Carmine is the best stain for fishes' teeth. If it is used, however, it is necessary before transferring to distilled water to pass the section quickly through weak $HC_2H_3O_2$ as this "fixes" the stain. If gold chloride is used the specimens must be mounted in glycerin-jelly. . . .

(5) It is unnecessary to cut sections of enamel to demonstrate the prisms. After having softened enamel by immersion in 10 per cent. solution of HCl, remove by means of a needle-point or fine brush a small portion to a slide; put a drop of normal salt solution on to the top of the enamel, and press down cover-glass. Then run a solution of carmine or orange-rubine beneath the cover-glass, and draw off the excess with a little blotting-paper. Wash the stain away further by irrigation with weak HCl, or $HC_2H_3O_2$, and mount in this solution or acidified glycerin after Beale's plan.

Examining Nuclei of White Blood-corpuscles.*—The ordinary notion about white corpuscles, viz. that the majority are polynucleated, is, says M. Mayet, quite erroneous. By this the author does not mean that polynucleated corpuscles are not demonstrable, but that this condition is extremely rare.

To ascertain exactly the shape of the nucleus, glacial acetic acid must be intimately mixed with the blood in the proportion of three to one.

By this means the red corpuscles are rendered almost invisible, while the extra-nuclear part of the white is more or less dissolved, so that the nuclei are isolated and become very visible.

The nucleus then is found to be of very variable shape, and it is owing to this irregularity that various optical effects are produced, so as to give the appearance of more than one nucleus. The nucleoli are always multiple, there being one for each swelling of the nucleus.

When a white corpuscle is really polynucleated, it is just in the act of division, nucleus and extra-nuclear plasma as well, but this condition is rare.

Studies in Cell-division.†—Prof. D. H. Campbell recommends the following subjects as specially well adapted for showing the various stages of division in the plant-cell, and its modifications; the paper is accompanied by very good figures:—For cell-division where there is no definite nucleus—*Nostoc*. For division of a multinucleate cell, and division of the nucleus independently of cell-division—*Cladophora*. For cell-division accompanied by the division of the single nucleus—*Spirogyra*. If exposed to cold during the night, and brought into the laboratory in the morning, some of the cells will probably begin to divide almost immediately. An interesting modification of the process is shown by many desmids. For following the process in the living cell—the hairs on the filaments of *Tradescantia virginica*. It is well shown by removing the stamens from the young buds, and mounting the attached hairs in water or in a 3 per cent. solution of sugar. They may be stained without killing them by a weak aqueous solution of methyl-violet, dahlia, or mauvein. For easy demonstration of the process of karyokinesis—the final divisions of the pollen-mother-cells,

* Comptes Rendus, cx. (1890) pp. 475–7.
† Bull. Torrey Bot. Club, xvii. (1890) pp. 113–21 (2 pls.).

especially of Monocotyledons as *Allium canadense*, or among Dycotyledons *Podophyllum peltatum*. The latter is especially favourable for showing the early stages, because of the small number (about ten) of the nuclear segments.

Dehydration and clearing up of Algæ.*—The following method, described by Dr. E. Overton, neither requires complicated apparatus nor demands a great expenditure of time, in obtaining a result more favourable than is usually expected when dealing with such delicate objects as Algæ, which shrivel or crumple up when transferred from one reagent to another.

The object, previously fixed and stained, is placed in a not too large quantity of 10 per cent. glycerin. Here it remains in an open vessel until the glycerin has given off nearly all its water. The objects are then transferred to absolute alcohol. Their further treatment depends on the nature of the clarifying medium. If turpentine, oil of cloves, or the like is to be employed, the object should be placed in a watch-glass, containing a 10 per cent. solution of the oil in absolute alcohol. The watch-glass is placed in a large covered vessel, on the floor of which are some pieces of calcium chloride to absorb the alcohol. In this way the objects are gradually impregnated with the pure oil, whereupon they may be transferred to dilute balsam. If before the objects be placed in the ethereal oil and alcohol mixture, they be passed through chloroform, this step will avoid the too great extraction of the staining by the spirit.

Should xylol be preferred for clearing up, then in the larger vessel pure xylol is placed as well as in the watch-glass. By a process of diffusion the inner vessel will ultimately contain almost pure xylol. By means of this method the most delicate algæ may be mounted in balsam without crumpling.

Amplification required to show Tubercle Bacilli.†—When properly stained and prepared, the bacillus tuberculi can be readily recognized with a good 1/5 objective and a 2-in. eye-piece, normal tube-length, or, roughly speaking, an amplification of 250 diameters. We do not think that it could be done much below this amplification, though the sharpness of vision of the observer, his acquaintance with the object, and the excellence of his objective would be important factors in settling the question. A 1/4 objective with a 2-in. eye-piece, normal tube-length, gives an approximate amplification of 200 diameters.

To be seen and diagnosed for certain, the bacillus tuberculi in urine or water must be prepared for examination by following the well-known technique in such cases (fixing, staining, bleaching, and mounting). No person who has any regard for his reputation as a microscopist would undertake to diagnose for certain bacilli of tubercle from other similar forms existing in water, urine, or any other medium whatever, whether with a magnification of 200 or 2000 diameters. The property of taking certain aniline stains, and retaining them so firmly that even nitric acid, diluted with only three volumes of water or alcohol, will not bleach them, is one peculiar to the tubercle bacillus, and shared, as far as we know, by the bacillus of leprosy only. This test, along with

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 11–13.
† Amer. Mon. Micr. Journ., x. (1889) pp. 277–8; from 'National Druggist.'

isolation and pure culture, alone makes the recognition of bacillus tuberculi certain.

For search of tubercle bacilli and study of the same, we have found a 1/10 homogeneous-immersion objective with a 2-in. eye-piece (approximately 500 diameters) the most satisfactory and least tiring to the eye. A good 1/8, however, with the same eye-piece, should be quite sufficient.

GRANDMAISON, F. DE.—**De l'emploi des solutions de chlorure de zinc pour la fixation des éléments anatomiques.** (On the use of solutions of chloride of zinc for fixing anatomical elements.)
Comptes rend. hebdom. Soc. de Biol., I. (1889) No. 39.

HOYER, H.—**Ueber ein für das Studium der directen Kerntheilung vorzüglich geeignetes Object.** (On an object particularly suitable for the study of direct nuclear division.) *Anat. Anz.*, V. (1890) No. 1, p. 26.

(4) Staining and Injecting.

Practical Notes.*—Mr. H. M. Wilder writes:—*Picric Acid Staining.*—Picrocarmine is very easily washed out with water, at any rate the picric acid. I prefer for that reason to stand the slide on edge, in order to let it drain off, and finally touch the section (or what else) *on the edge* with blotting-paper or filtering-paper, but I do *not* put the blotter *on top;* even the best, and handled most carefully, will always leave fibres. I then allow the section to dry a little, and finally put on the medium. If in balsam I let the section dry thoroughly; the benzole balsam will soon clear it, without any alcohol or oil of cloves. That is for vegetable tissues.

To mount Powders.—In mounting powders I much prefer to breathe on the slide, press it on the dry powder, provided the firmness of the powder is tolerably uniform, give a few smart raps with the edge of the slide on the table, in order to get rid of superfluous powder, put on the cover-glass, with a pencil-brush dust off the surrounding powder, and let the medium *run under* by capillary attraction in the well-known way with a couple of drops on the side of the cover-glass. In this way I seldom have any air-bubbles to contend with.

Silicate of Sodium (soluble glass, water-glass) I would strongly recommend as a medium for vegetable sections and powders. It "sets" quickly, less than fifteen minutes after a mount is made; the slide can be cleaned with a nail-brush without fear of the cover-glass coming off. It clears well, and acts as its own cement, no ringing being necessary. Its disadvantages are: it does not agree with alcohol, ether, volatile oils, mucilage, acids (not even very weak), collodion; being alkaline it will colour lignified tissue yellow, and alter the shades of stains more or less (the bluish-purple colour of hæmatoxylin is turned sepia-brown). After some time it deposits "crystals," that is flakes, which, while they detract from the beauty of the slide, cannot well mislead any one; this tendency may, however, be largely obviated by using a mixture of four or five fluid parts of the silicate and one part of glycerin. This mixture is, of course, slow in drying.

Note.—Mucilage and water-glass do not well mix, because mucilage is always more or less acid; water-glass is very intolerant of acid.

* Micr. Bull. and Sci. News, vii. (1890) p. 17.

Staining of Vegetable Nuclei.*—The following is the method employed by Mr. H. W. T. Wager in staining the nuclei in *Peronospora parasitica*, parasitic on the shepherd's purse (see p. 491). The sections were made by the Cambridge ribbon-section-cutting microtome. The fresh infected tissues of the host-plant were cut up into small pieces, and placed at once either in absolute alcohol or in chromic acid solution, where they were kept until thoroughly penetrated, and were then prepared for imbedding in paraffin-wax. The chromic acid specimens were thoroughly washed in 70 per cent. alcohol, then transferred to methylated alcohol, and finally to absolute alcohol. The pieces of tissue may then be stained *en bloc*, or the separate sections may be stained, when cut, on the slide. The latter gave the best results.

After being thoroughly dehydrated by alcohol, the pieces of tissue were transferred to turpentine for about forty-eight hours, and were then placed in soft melted paraffin-wax for about twenty-four hours, and finally transferred into hard melted paraffin-wax for about two days. They were then imbedded in small square blocks of paraffin, and very thin sections cut by the microtome. These sections were cemented to the slide by a solution of white of egg and glycerin, and the paraffin-wax melted by heating the slide on a water-bath, and washed off in turpentine. The slide was next placed in absolute alcohol, and afterwards transferred to a dilute solution of Kleinenberg's hæmatoxylin in water, made by adding a few drops of the strong hæmatoxylin solution to a beaker of water, until the whole was decidedly coloured. The sections were left in this until they were considerably over-stained, and were then placed in a dilute solution of acid alcohol, made by adding a few drops of strong hydrochloric acid to a beaker of 70 per cent. alcohol for a short time to reduce the stain. They were then washed successively in 70 per cent., 90 per cent., and 100 per cent. alcohol, and were next transferred for a few minutes to turpentine until quite clear and transparent, and were finally mounted in Canada balsam. The preparations thus obtained, which were in many cases only about 1/8000 in. in thickness, exhibited the structure of the nucleus clearly and distinctly.

Nessler's Ammonia Test as a Micro-chemical Reagent for Tannin.†—Mr. S. Moore writes: In most cases the presence of tannin is immediately shown by all the ordinary reagents used by the botanist for its discovery. This does not happen sometimes, however, as, for instance, in the tannin-cells found in the epidermis on the dorsal side of the leaves of some plants. As a good typical example the common primrose may be cited. Of all the ordinary tests, including iron salts, potassium bichromate, Möll's test (copper acetate and iron acetate), ammonium molybdate, and osmic acid in 1 per cent. solution, the latter alone acts immediately upon the tannin in the primrose leaf's epidermis. It may hence be worth while recording the discovery of a second reagent capable of acting rapidly and effectively; and one which is easily made and will keep for some time should be especially valuable. Such a reagent is Nessler's test for ammonia.

Nessler's test is made, as all the world knows, by saturating a solution of potassium iodide with mercuric iodide, and adding an excess

* Ann. of Bot., iv. (1890) p. 131.

† Nature, xli. (1890) pp. 585-6.

of caustic potash. Ammonia gives with this a reddish precipitate; tannin a brown, and when in considerable quantity a deep black one; but if little tannin be present, the brown may tend towards purple. It goes without saying that much experiment must be undertaken before one can be sure of the substance giving the brown precipitate being really tannin. To be conclusive, such experiment should be carried out in four different directions:—

(1) The reaction ought to be given in all cases when the ordinary reagents make their presence immediately felt.

(2) Cells which will not immediately give the tannin reaction with ordinary tests, but which will do so with Nessler's test, must also do so under the former conditions if time be allowed.

(3) Tissues, which will not yield the reaction with Nessler's test, must not give it with any other reagent, even after the lapse of some time.

(4) Solutions of tannin must give a brown precipitate with Nessler's test.

Under the first of these headings may be mentioned growing shoots of the garden rose. On laying a radial longitudinal or a tangential section of this in Nessler's fluid, a copious black-brown precipitate is obtained, and the same thing occurs with the beautiful tannin-sacs of *Musa sapientium.* In all other instances, where tannin has betrayed its presence by the use of ordinary reagents, the brown colour has been obtained upon treatment with Nessler's test.

The primrose leaf may be again cited as an example of the time sometimes necessary to show up tannin with the usual reagents, of which it must here suffice to particularize ammonium molybdate. On laying in the molybdate a small piece of epidermis torn off the lower side of the leaf, one first sees a cell here and there coloured the characteristic and beautiful yellow given by this test: these coloured cells are usually situated among the elongated more or less rectangular cells overlying the vascular bundles. Re-examination after half an hour or so shows several more of the cells similarly coloured, but it is usually not till after a couple of hours that one can safely declare all the tannin-containing cells to have been stained. With variations in respect of time, and with the sole exception of osmic acid, all the other tests act in precisely the same way; even Möll's, preferred to all others by some of our Continental *confrères*, being as unsatisfactory as the rest. But sooner or later its characteristic colour is imparted to these cells by every reagent, thus proving tannin to be present.

For the negative experiment the absence of the brown colour from tissues treated with Nessler's fluid, and its absence from the same tissues when acted upon by ordinary tannin reagents, recourse was again had to epidermis. The experiment succeeded in all cases; among these may be cited *Fatsia japonica*, wallflower, box, *Stellaria media*, and *Pelargonium zonale.* In none of these did tannin show up, although twenty-four hours were allowed to elapse before the preparations were destroyed.

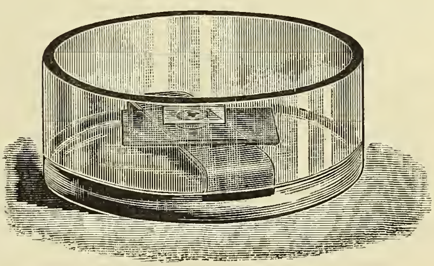
Lastly, Nessler's fluid gives a rich brown precipitate with solutions of tannin. Moreover, with gallic acid a grey-green one is thrown down, thus affording an easy means of distinguishing between these bodies.

For these reasons, therefore, viz. the rapidity, certainty, and distinctness of its action; the ease with which it can be made; its permanence when made; and lastly, the difference in its behaviour towards tannin and towards gallic acid—for these reasons I am bold enough to anticipate the time when, to adapt a hackneyed expression, Nessler's fluid will be regarded as a reagent which no botanical laboratory should be without.

Staining and Imbedding very Minute Objects.*—The preparation of microscopically small objects is usually a very unsatisfactory procedure, but very good results may be obtained, says Dr. E. Overton, by adopting the following method:—Suppose the material is a hanging-drop cultivation on a cover-glass, as for example unicellular algæ, Flagellata, pollen-tube, or the like. When the cultivation has reached the desired stage of development, the cover-glass is removed and iodine vapour allowed to stream over it. Iodine vapour is easily obtained by putting some crystals in a test-tube and warming them. Instead of iodine, osmic acid or its vapour may be used, but then manipulation is extremely difficult, not to say unsatisfactory.

By this method the objects are fixed at once, and then the iodine is removed by heating the preparation up to about 40° for 2–3 minutes. It is sometimes necessary to add a drop of distilled water during the evaporation of the iodine. The cover-glass, with the moist side still uppermost, is then put on a piece of elder-pith, about 3 mm. thick, and with a diameter rather less than the cover-glass. This, in its turn, rests upon a slide (Giessen size), which is placed in a glass capsule, the sides of which are about 2 cm. high. The slide does not lie on the bottom of the capsule, but is placed on a sort of little stool made of metal (see fig. 59).

Fig. 59.



To the preparation is added a drop of 20 per cent. alcohol and absolute alcohol in the capsule, the layer reaching half-way up the stool. The capsule is covered over and sealed up with vaselin. The vessel must be kept at an equal and moderate temperature, and not exposed to the sunlight. In a few hours the alcohol will have acted sufficiently upon the preparation. It is then removed and covered with a drop of collodion, or a solution of celloidin. When the celloidin has set a little, it is immersed in 80 per cent. spirit, wherein it becomes firmly set in about two minutes, so that the preparation may now be placed in any staining solution without fear of damage. The celloidin solution must be quite thin; the author uses the commercial solution diluted with six to ten parts of a mixture of equal parts of alcohol and ether.

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 13–16 (1 fig.).

The best stains are carmine and hæmatoxylin, or eosin, iodine-green, and fuchsin. Other anilin dyes, as gentian-violet, are not suitable. The preparations should be dehydrated in 80 to 85 per cent. spirit, and then cleared up with creosote, or with a mixture of equal parts of 90 per cent. alcohol and creosote. They are then mounted in balsam, after having first passed through xylol.

Although this method may appear complicated, in reality it saves a great deal of time.

Surface Deposits in Golgi's Method.*—Sig. P. Samassa, in criticizing Sehrwald's method for preventing surface deposits in sections treated by Golgi's method,† points out that in the original method of Golgi these surface deposits are considerably less. Hence, as in the latter no cover-glass is used, it is an obvious inference that the pressure of the glass sets up diffusion currents, whereby the precipitate is scattered over the section, and renders it often quite useless. The diffusion process is aided by the evaporation of the solvent. In the uncovered method, owing to the large area exposed to evaporation, these diffusion currents are not so likely to occur with such violence as when confined between two rigid layers.

Staining Elastic Fibres and the Corneous Layer of Skin.‡—Herr A. Köppen, in a continuation of the technique of staining elastic fibres,§ recommends a double staining, which may be either diffuse or nuclear.

For diffuse staining the following solution is used:—Carmin optim. 1·0 is dissolved in 50 ccm. cold water, then 5 ccm. liq. ammon. caust. is added, and the whole allowed to stand for two days. It is then filtered, and of the filtrate 1 drop is used to 20 ccm. water. The sections remain therein for twenty-four hours, and are then stained a diffuse red.

Staining of the nuclei and protoplasm.—(1) Weigert's picrocarmine stain is made by adding to the above solution 50 ccm. of a saturated aqueous solution of picric acid. This solution, which should be filtered before and after use, stains in from two minutes to several hours. (2) Grenacher's alum-carmine is made by boiling together for 15 minutes, and then filtering, carmine 1·0; alum 5·0; water 50·0.

The advantage of using these preliminary stains is that the subsequent decolorizing is extremely rapid.

Decolorizing Preparations over-blackened by Osmic Acid.‖—The method of decolorizing objects over-blackened by osmic acid by means of peroxide of hydrogen was, says Dr. E. Overton, first introduced by Fol, but is so little practised that it merits a word in its favour. The following solution, which should be prepared every time, is recommended by the author:—Commercial peroxide of hydrogen 1 part; alcohol (70–80 per cent.) 10–25 parts. The removal of the osmium is completed in a few minutes, and the preparations stain excellently.

Staining Sections of Botanical Preparations.¶—Dr. A. Zimmermann gives a short description of some methods for staining botanical pre-

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 26–8. † See this Journal, *ante*, p. 410.
‡ Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 22–5. § See this Journal, *ante*, p. 410.
‖ Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 10–12. ¶ T. c., pp. 1–8 (1 fig.).

parations, which he has found useful in the examination of chromatophores, crystalloids, and various cytoplasmic elements.

(1) Picro-fuchsin stain.—The sections are fixed to the slide, and the paraffin and its solvent xylol having been removed, are placed in a solution of acid-fuchsin, which is made by dissolving 20 grm. of the pigment in 100 ccm. of anilin water. In this solution, which should be gently warmed, the sections remain for 2–5 minutes, and are then washed in a mixture of 1 part of a saturated alcoholic solution of picric acid and 2 parts of water until no more dye is given off. After this the picric acid is to be extracted in absolute alcohol; then the sections are passed through xylol and mounted in xylol balsam.

(2) Acid-fuchsin staining, with subsequent washing out in flowing water.—This method is serviceable for staining thick sections made from living tissue and then fixed. After the fixative is extracted the sections are placed in a 0·2 per cent. watery solution of acid-fuchsin, in which they remain for 24 hours or longer. The excess of stain is then extracted in flowing water, and this is best done by means of Steinach's glass filter capsules.* The capsules are placed in a receiver, over which is a pipe with a number of small taps, from which the water can be made to flow into the capsules. In adopting this method it is advisable to manipulate a large number of sections at once, and to examine them from time to time to ascertain the proper degree of decoloration.

(3) Iodine-green for staining chromatophores.—The sections are made from tissue previously fixed with an alcoholic sublimate solution, and then immersed for half an hour in a saturated aqueous solution of iodine-green. They are then washed in water and examined in glycerin or Hoyer's mounting fluid, or in balsam. If balsam be used, then dehydration must be effected by merely drying the preparation. Then xylol is added, and, when saturated with this, the xylol balsam. As a contrast stain for the rest of the tissue, a watery solution of Bismarck brown may be used.

(4) Ammonia-fuchsin for staining the chromatophores.—This stain is prepared by adding chemically pure ammonia to an alcoholic solution of fuchsin until the fluid assumes a bright yellow colour. The solution may be used at once, but will only keep a few weeks. The sections are fixed to a slide and some of the solution poured thereon and allowed to remain for some few minutes. They are then washed and examined in water or glycerin. Hoyer's mounting medium may be used, or even balsam. If the latter, then the sections must be dehydrated by drying them in the air.

Staining Human Retina with Acid Hæmatoxylin.†—Dr. J. Schaffer has been able to differentiate the outer and inner segments of the rod and cone layer of human retina by staining the tissue with the acid logwood recommended by Kultschitzky.

The sections, imbedded in celloidin, are taken from the Müller's fluid or alcohol in which they have been fixed and hardened, and left during the night in a 1 per cent. solution of chromic acid, which acts as

* This Journal, 1888, p. 850.

† SB. K.K. Akad. Wiss. Wien, xcix. (1890) pp. 110–20 (1 pl.).

a mordant. After having been washed they are placed in the logwood solution for about twenty hours. The overstaining is removed by decolorizing with Weigert's borax and ferrocyanide of potash solution. The proper degree of differentiation is attained when the rod and cone layer alone remains of a dark colour, the rest of the layers having a brownish hue to the naked eye. The sections are then washed in water and mounted in balsam in the usual manner.

Hæmatoxylin as a means for ascertaining the Alkalinity or Acidity of Tissues.*—Prof. F. Sanfelice has found that the acid or alkaline reaction of tissues may be recognized by staining with Boehmer's hæmatoxylin (alkaline), or with the author's iodized hæmatoxylin (acid).†

In using this method as a test, two principal precautions must be observed. First it is necessary that the normal reaction of the tissue must not be interfered with, hence reagents such as chromic acid and its salts, Müller's fluid and Flemming's solution are unsuitable fixatives. The author used chiefly absolute alcohol for hardening and fixing, and also corrosive sublimate, the excess of which must always be carefully extracted with spirit. The second precaution is that the hæmatoxylin solution must have only a feeble reaction.

Among the instances of differential staining obtained by this method it is mentioned by the author that the protoplasm masses in the ovary and testicle of Selachians are coloured red when the whole of the tissue is treated with the alkaline solution—a fact which proves that the elements undergoing this form of necrobiosis acquire an acid reaction. Goblet-cells in the intestinal mucosa become coloured blue, while the rest of the tissue remains red. Hence the reaction of goblet-cells is alkaline, and this method might be usefully employed to ascertain the reaction of tissues or elements, and their products.

New Method of Staining Central Nervous System, and its Results.‡—Prof. P. Flechsig recommends the following method for staining the nerve-cells of the cerebral cortex and their prolongations. By means of it it was shown that the axis-cylinder process was the only prolongation from the cell which was in connection with a nerve-fibre; that the axis-process, which is not at its commencement medullated, divides like a T, i. e. dichotomously at a right angle. In the occipital lobe a trichotomous subdivision was the rule, although frequent subdivision was also remarked. In the neighbourhood of the central fissure some axis-fibres did not subdivide.

These results were obtained by hardening pieces in 2 per cent. aqueous solution of chromate of potash, and then making sections not exceeding 5/100 mm. in thickness.

After soaking in 96 per cent. spirit, the sections are kept for 3–8 days in a solution of redwood extract at a temperature of 35° C. The sections having been washed in distilled water are then decolorized in the following manner:—Each section is placed in 3 ccm. 1/4–1/5 per cent. solution of permanganate of potash until the solution have lost its

* Journ. de Micrographie, xiv. (1890) pp. 21–2.
† See this Journal, 1889, p. 837.
‡ Berichte ü. d. Verhandl. K. Sächs. Gesell. Wiss. Leipzig, 1890, pp. 328–30 (1 pl.).

bluish colour; it is then immersed in the decolorizer (distilled water 200, oxalic acid 1, hyposulphite of potash 1), until all traces of yellowness have departed from the section.

The redwood solution is made as follows:—1 gram of the pure extract of Japan redwood is dissolved in 10 grams of absolute alcohol, and then diluted with 900 grams of distilled water. To this are added 5 grams of a saturated solution of Glauber's salt and a similar quantity of a saturated solution of tartaric acid.

If this redwood method be combined with Golgi's sublimate staining, the sections, having been stained as above, are placed in a mixture of 20 ccm. absolute alcohol and 5 drops of 1 per cent. solution of chloride of gold and potash, until the sublimate precipitate have become quite black, and the red nerve-fibres have assumed a bluish tone. They are then washed in 10 grams of distilled water, to which 1 drop of a 5 per cent. solution of cyanide of potash has been added, then dehydrated in absolute alcohol, cleared up in oil of lavender, and mounted in balsam.

Burchardt, E.—**Eine neue Amyloïdfärbung.** (A new amyloid stain.) *Virchow's Arch.*, CXVII. (1889). Cf. *Fortschr. d. Med.*, VII. (1889) No. 23, p. 901; *Centralbl. f. Klin. Med.*, XI. (1890) No. 4, p. 74.

Dekhuyzen, M. C.—**Ueber das Imprägniren lebender Gewebe mit Silbernitrat.** (On the impregnation of living tissues with silver nitrate.) *Anat. Anz.*, IV. (1889) No. 25, p. 789.

Nickel, E.—**Die Farbenreactionen der Kohlenstoffverbindungen. Für chemische, physiologische, mikrochemische, botanische, medicinische und pharmakologische Untersuchungen.** (The colour-reactions of carbon-compounds. For chemical, physiological, micro-chemical, botanical, medical, and pharmacological investigations.) 2nd ed., Berlin (Peters), 1890, 8vo, 134 pp.

(5) Mounting, including Slides, Preservative Fluids, &c.

Finishing Balsam Mounts.*—Mr. F. N. Pease finishes balsam mounts as follows:—The object is mounted on the slide, applying the cover-glass in the ordinary manner, using either balsam, hardened balsam, balsam and benzol, storax or dammar. The slide is then heated to drive off the solvent or more volatile constituents, either gently in a water-bath or at a higher heat, even boiling carefully over a spirit-lamp when the nature of the object will permit. When cold, the superfluous mounting medium is carefully removed, then a narrow ring of paraffin-wax is heated in a capsule until it is melted and quite limpid. With the aid of a very small camel's hair pencil, the melted paraffin is applied at the edge of the cover-glass, covering the exposed medium and instantly solidifying. It is now necessary to apply a finishing cement. For this purpose Bell's cement has been found excellent. If this cement does not work satisfactorily the admixture of some chloroform makes it work smoothly. This cement ring is finished at one application, and in a few hours the slide is ready for the cabinet.

This method is intended to protect the mounting medium from becoming discoloured owing to atmospheric influences.

A new Diatom Mounting Medium.†—Mr. F. W. Weir writes, "$C_{10}H_7Br$ + Resin of Tolu.—Dissolve 3 oz. of commercial balsam tolu

* Amer. Mon. Micr. Journ., xi. (1890) pp. 66–7.
† Micr. Bull. and Sci. News, vii. (1890) pp. 23–4

in 4 fluid drachms of benzine (C_6H_6) at a temperature of about 45° C., and strain. Add 4 fluid oz. of carbon bisulphide, agitate thoroughly, and allow to cool, when the tolu solution will separate and the carbon bisulphide with cinnamic acid in solution can be decanted. Add another portion of the carbon bisulphide and treat as before. Finally pour the tolu solution into a glass tray and evaporate the benzine.

Place in a 1/2 oz. glass-stoppered phial 1 fluid drachm of naphthaline monobromide, and add gradually about three times its volume of the resin of tolu, or sufficient to make the mixture quite stiff when cold. The solution will be effected slowly at about 45° C. The above constitutes a mounting medium which is rather easier to use than Canada balsam.

Warm the medium at 40° to 45° C. until quite fluid, take up a minute quantity on a warm needle, place on centre of cover-glass and invert on slide. Use no pressure whatever, but warm the slide gently, when the medium will flow to edge of cover.

After a few days ring with a non-alcoholic cement. This method of treating balsam tolu does not remove an atom of resin, and does not allow an atom of cinnamic acid to remain.

The subsequent solution in naphthaline monobromide produces a medium of higher index (1·73) than the resin alone, permanent in structure and volume, and free from objections to which any medium in a volatile solvent is subject."

Tolu and Monobromide.*—Mr. H. L. Smith writes to the Editor of the 'Microscopical Bulletin':—

"I meant to reply to your letter before. The bromide medium will keep if *tightly sealed*, but almost all cements, and some coloured waxes, decompose it. I must say I am not satisfied, and would not advise any one to use it. The yellow medium can be made to keep, but I don't like the colour.

Mr. Weir, of Norwich, Conn., sent me a compound of monobromide of naphthaline and tolu, which is best of any of the high mediums yet—no crystals, easy to use, and very satisfactory.

He is about publishing the formula. I wish somebody—you or some one—would make it for sale, as he does not intend to do this. It has full as high index as monobromide, and none of its disadvantages.

It has consistency of ordinary balsam, and is used like that. It can be hardened by careful heat; or better, mount without heat, and in a day or so it will harden to allow asphalting, or in a few more days will need no ring. It is going to do the thing, I *guess*.

Nothing could please me more than to have you make the bromide medium if I could advise it. It keeps perfectly well in the bottle. I have it two and three years old. No decomposition at all, but it acts so powerfully on all cements, that *this* prevents its usefulness. The index is considerably above monobromide, but the latter is high enough, and I am pretty well pleased with it."

Fixing Sections with Uncoagulated Albumen.†—Dr. J. Rabinovicz has found that albumen may be used for fixing sections to the slide by

* Micr. Bull. and Sci. News, vii. (1890) p. 24.
† Zeitschr. f. Wiss. Mikr., vii. (1890) p. 29.

adhesion as well as by coagulation, and the method is as follows:—The sections are laid on the slide, covered with albumen, and pressed down with a brush. The slide is then put straight into toluol until the paraffin is dissolved. The time required for this varies with the quantity of paraffin (from one to five minutes). The specimen may then be mounted in balsam. If there be any glycerin, however little, mixed with the albumen, this must be removed by immersion of the slide in absolute alcohol for five to ten minutes.

This method has the advantage over others in that it is shorter, and that the albumen is not coagulated by heat or spirit.

(6) Miscellaneous.

New Reaction for Albuminoids.*—Herr C. Reichl proposes the following test for albuminoids, which, though not so sensitive as Millon's reagent, may yet be of service in micro-chemico-botanical investigations. Two or three drops of a dilute alcoholic solution of benzaldehyd, a moderate quantity of dilute sulphuric acid (equal parts of acid and of water), and a drop of solution of ferric sulphate, give a dark blue colour with an albuminoid. A light blue colour is brought out by the first two substances, which becomes deep blue by the action of the ferric sulphate. Concentrated hydrochloric acid may be used in place of the sulphuric, and a different soluble iron salt, for example the chloride, in place of the sulphate.

WHEATCROFT, W. G.—**Presidential Address to the Bath Microscopical Society.** *Journ. of Micr.*, III. (1890) pp. 48–52.

* SB. K.K. Akad. Wiss. Wien, Monatsheft f. Chemie, 1889, p. 317. See Bot. Centralbl., xlii. (1890) p. 367.

PROCEEDINGS OF THE SOCIETY.

Meeting of 18th June, 1890, at 20, Hanover Square, W., Frank Crisp, Esq., B.A., LL.B., V.P.L.S., in the Chair.

The Minutes of the meeting of 21st May last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Specimens of *Patella pellucida*	*Mr. W. B. Strugnall.*
Flint-glass slide of mixed Diatoms	*Dr. H. Van Heurck.*

Mr. J. Mayall, jun., said the flint-glass slide received from Dr. H. Van Heurck, Director of the Botanical Garden, Antwerp, had been forwarded to replace the slide received from Prof. Abbe with the new 1/10 objective of 1·6 N.A., which slide had unfortunately become so deteriorated by partial crystallization of the extra-dense mounting medium that it had not been possible to test the objective satisfactorily. The new slide was stated by Dr. Van Heurck to contain several fine specimens, and it was hoped that it would facilitate the preparation of the report on the objective.

Mr. Mayall mentioned in explanation of the delay in bringing forward the report on the new objective, that before the committee—consisting of Dr. Dallinger, Mr. E. M. Nelson, and himself—met officially to examine the objective, it had been agreed to support the report by the production of photomicrographs of the various objects used as tests. With this view, Mr. Nelson and himself met, and after devoting several hours to the examination of sundry diatoms, on some of which the definition was remarkably good, it was decided to photograph the best fractured valve of *P. angulatum* observed on the slide. They were, however, disappointed to find that the visual and actinic foci were not coincident, which fact was demonstrated (1) by the visual image that had been accurately focused appearing in the photographs wholly indistinct; (2) by Mr. Nelson's guessing what focal allowance to make, so that the out-of-visual-focus-image came out very nearly sharp in the photograph; and (3), in further proof of the point, a coarsely marked diatom, as to the focus of which there could not be a doubt, was first accurately focused, then photographed, the photograph appearing wholly indistinct. The focus was then altered by Mr. Nelson by an amount which he roughly estimated would suffice. The visual image was then wholly indistinct, but the photograph produced of it was very nearly sharp—very nearly as sharp as the image could be seen in the Microscope when accurately focused. Under these circumstances the possibility of producing critically good illustrative photographs with the objective as it then was seemed very doubtful; it was therefore decided, with Dr. Dallinger's consent, to communicate the facts to Prof. Abbe, and by his request the objective was returned to Jena. After the lapse of

several weeks Dr. Czapski replied that he had not found any trace of a "chemical" focus non-coincident with the visual focus, and the objective was again forwarded to London. The committee then met, and the same fractured valve of *P. angulatum* was focused accurately and then photographed, and it appeared quite sharp in the photograph. The transit of the objective from London to Jena had somehow got rid of the "chemical" focus. Unfortunately, as he had already stated, the slide had become seriously deteriorated, so that the critical tests which they intended to photograph could no longer be tried. They were therefore compelled to wait the arrival of another slide, which Dr. Van Heurck had most kindly sent; but which the committee had not yet been able to examine. He trusted the matter would be dealt with satisfactorily during the recess, though he must express his regret that the trials would necessarily be limited to the one slide, the diatoms on which had undergone very rough treatment in being imbedded in the surface of the flint glass by melting, and by the addition of the dense mounting medium, which, according to Dr. Van Heurck's statement, required a temperature of 400–500° Centigrade for its preparation whilst actually on the slide.

Mr. Andrew Pringle's letter was read, in which he expressed his regret at not being able to attend the meeting to describe the new photomicrographic apparatus recently made to his instructions, by Messrs. Swift and Son, for the Royal Veterinary College.

Mr. Mayall said Mr. Pringle's letter had reached him only a few minutes before the Council meeting; but as he had had an opportunity of examining the apparatus before it was brought to the Society, he would endeavour to call attention to the principal points. From the very early days of photography the Society had been kept well informed of the progress of photomicrography, and had from time to time received a great number of photographs representing the progress made. They had also received many communications describing the apparatus and methods employed. The most notable, from every point of view, were the photomicrographs produced by the late Dr. J. J. Woodward, of Washington, who had been most careful and exact in describing his methods and in figuring the installation of his apparatus, which was, without doubt, the most perfect of its date. In Dr. Woodward's work every branch of microscopy extant in his time had been dealt with, so that his successors were bound to rate their progress by comparison with his work, which was, however, wholly produced before the days of the modern "dry-plate" processes of photography. The simplification of the manipulations due to the dry-plate photography had greatly popularized photomicrography, so that nearly every microscopist who had tried his hand at producing a few photographs, considered himself justified in devising some special form of apparatus, as evidenced by the enormous mass of appliances that had been figured and described in the Society's Journal.

Hitherto it might be said that the inventors had generally limited their efforts to the application of some form of camera to an existing type of Microscope, the latter being the particular instrument with which they were most familiar. Even Dr. Woodward, who had practically unlimited means at his disposal, contented himself with combining his favourite Microscope (Powell and Lealand's No. 1 model) with a

substantially-made camera, or movable screen, using such precautions as he could devise to give the whole apparatus the greatest possible steadiness. Chevalier, Hartnack, Nachet, and other opticians, including Zeiss, who had devised photomicrographic apparatus, had never, so far as he knew, attempted to plan a Microscope specially for the work; they had all adapted some form of camera to the ordinary Microscopes constructed by them. Mr. Pringle had, however, made a new departure. Having devoted much attention to the photographic processes, he became interested in photomicrography, and in his recently published volume on that subject, he frankly acknowledged that he was indebted to Mr. Nelson for all his best experience in the use of the Microscope; he was, therefore, familiar with Mr. Nelson's apparatus and his methods of work. With the experience thus gained, he considered it essential to have sundry modifications made in the Microscope itself with a view to attaining greater general stability, especially as the instrument was intended principally for high-class work, and no expense was to be spared to make it as efficient as possible. He explained his plans to Messrs. Swift, giving them general instructions to produce the best mechanism they could make. The result was the apparatus exhibited at the meeting. Of the photographic arrangement—the extensible camera and the oxyhydrogen lamp—little need be said beyond noting that it seemed very well and conveniently devised. He should himself have preferred a solid wood box-camera made in sections like Mr. Nelson's; but that was by no means a vital point. He had no doubt that with an extensible bellows camera quite as good work could be done as with a box-camera; the preference, then, was a matter of individual choice—the essential matter was that the apparatus should be accurately made, and as free as possible from vibration. With a solid wood box-camera made in sections, weights could be conveniently applied to stop vibration at the end where the sensitive plate was placed; in the bellows arrangement clamp-screws were relied upon—in either way no appreciable vibration need occur. The oxyhydrogen lamp required a great number of adjustments to be made readily; the lime cylinder had to be raised, or lowered, or turned, or it had to be brought nearer to or slid further from the Microscope; for effecting these movements rapidly and accurately substantial mechanism was applied.

As to the Microscope, he supposed that Mr. Pringle had instructed Messrs. Swift to provide a substantial extra support at the eye-piece end to insure steadiness when the instrument was in the horizontal position, and had left all the other details of the construction to be carried out by them on their own plans. But that involved a new departure, for the addition of the support at the eye-piece end was a point essentially novel, and as it gave additional stability, he thought it would probably be adopted, with more or less modification, as an adjunct to all the best photomicrographic arrangements henceforth, for its merits were unquestionable; moreover, the plan was easily applicable to any form of Microscope. Messrs. Swift had adopted the "Jackson" form of limb, modifying the usual modern construction by making it long enough to support the whole length of the body-tube, both when high or low powers were in use, thus reverting in principle to Jackson's original design, which had been rather neglected in recent times. The Jackson form of Microscope, as usually made by the American and English

opticians, was defective in the matter of the fine-adjustment—a most vital point in an instrument intended for critical work. Some five years ago, Messrs. Swift worked out a new and special system of fine-adjustment applicable to the Jackson model, which he had noticed at the time as being the most important improvement in that form of Microscope made up to that date. At that time the action of the mechanism was upon the nose-piece only, within the body-tube; but later on it was found that the bearings, &c., could be more exactly fitted by arranging the mechanism to act on the whole body-tube, and that was the system adopted in the new Microscope. The great length and breadth of the bearing slides secured steadiness, at the same time providing ample space for the screw and long-lever action which could thus be made unusually strong and yet sensitive. The stage and substage supports were shaped as recommended by the late Mr. Tolles, of Boston, so as to be strengthened at the parts where they were attached to the stand. The mechanical movements of the stage seemed very elaborate, and whilst admitting the great convenience of having such movements, he thought the microscopist would do well to learn to manipulate without them; or if that were too severe a task, then he thought his own mechanical stage—which moved the object about on the surface of the stage proper, without the intervention of moving plates—would be more serviceable, especially if strong clamping stage springs were brought to bear upon the slide when once got into the position required. The base and trestle supports of the Microscope were of unusual strength; the two brass trestles supporting the trunnion axis were held together by a V-piece after the manner of some of Troughton's small transit instruments; a third brass trestle supported the eye-piece end of the body-tube, the three trestles being screwed to an oblong brass base-plate pierced in the centre for the application of a clamping screw. The base-plate itself was fixed to a strong disc of mahogany—a sort of turn-table—having a tail-piece to carry the oxyhydrogen lamp, the whole rotating in or out of the axis of the camera, a stud-piece stopping it when in the axis, and the clamp-screw fixed it. The intention was that the microscopist would be seated, and would adjust the Microscope by rotating the instrument away from the camera, and then swing it in a line with the camera and clamp it. At the eye-piece end the trestle-support had a screw arrangement for collimating the optical image in the vertical direction on the centre of the focusing-screen. The frame carrying the focusing-screen was also provided with a small range of motion for centering the image. For photographic work the fine-adjustment screw was actuated by a system of pulleys and a silk cord kept at moderate tension by two straight springs; a long rod on fittings at the side of the camera had an indiarubber ring on the cylindrical head, which engaged by friction on a large milled head connected with the silk cord. The motion was very smooth and regular.

Without pledging himself to approve of every detail of the design, as being the best known arrangement, he thought Mr. Pringle was to be congratulated for his share in the production of the apparatus. Messrs. Swift had had a difficult task before them in constructing such an instrument, and they had accomplished their work in a most creditable manner. His own testing had been limited to the Microscope, especially the fine-adjustment, and he was glad to be able to say he found the

action extremely accurate and sensitive when severely tried. He had suggested to Messrs. Swift the advisability of clamping the body-tube, and the mechanical stage when the adjustments were made, and he understood the matter would be dealt with.

Mr. E. M. Nelson said, as regarded the general stability of the whole apparatus, he could endorse all that Mr. Mayall had said about it; but he thought it was obtained at too great a sacrifice, as the Microscope would have to be kept specially and wholly for photomicrographic work. He did not like the rotation of the Microscope with the wooden turn-table, for that seemed to him a lazy way of working; he much preferred the standing position for making the adjustments. He knew of nothing more ridiculous than the picture in Zeiss's catalogue of photomicrographic apparatus of a man sitting and adjusting the horizontal Microscope: such a position for work was quite absurd. There must be a rest for the arms, and unless a person was utterly decrepit, he should stand up to do work of that sort. He disapproved of Messrs. Swift's arrangement of the focusing cord tightened by pressure of springs with pulley wheels. The cord should not be regulated by springs, but should be drawn quite tight by a screw arrangement; he estimated the proper degree of tightness in his own apparatus by its emitting a shrill note when tried by the finger. In this way he was certain of his focus. The plan of using indiarubber in contact with the milled head was quite a mistake, he had tried that and many other similar things, but they were all radically bad. The only really certain way of focusing from a distance was to use the tight cord he had mentioned. Another fatal objection was that the Microscope was not adapted for the use of Zeiss's projection eye-pieces. He also criticized sundry points of detail in the arrangement of the camera, &c. He thought that with the springs taken away, and the other matters he had spoken of put right, the apparatus would be greatly improved. It was beautifully designed, and beautifully made, as all Messrs. Swift's work was.

Mr. T. F. Smith quite agreed with Mr. Nelson's views.

Mr. J. Swift said all the minor points referred to by Mr. Nelson as to the arrangement of the camera, the focusing screens, and sensitive plate-holders, really had been met, although he had not thought it necessary to bring everything forward at the meeting. He thought Mr. Nelson was mistaken in supposing there was only one way of arranging the focus from a distance successfully. He believed the plan adopted would be found efficient in practice. As to Mr. Nelson's preference for a standing position in making the adjustments, it was not a matter for argument. The collimating arrangement at the end of the Microscope would be found useful, as it acted very readily and accurately where placed. Mr. Nelson was in error in supposing the tube had not been arranged to take Zeiss's projection eye-pieces. Mr. Pringle brought him Zeiss's achromatic condenser, and a projection eye-piece, so that there might be no mistake about their fitting properly on the instrument.

Mr. Mayall observed that the collimating screw, as devised, moved the Microscope in relation to the lamp, so that it would require to be adjusted before the condenser was centered. He thought Mr. Nelson's contention in favour of the standing position was hardly serious. He had worked with the Microscope for upwards of an hour, sitting on an

ordinary chair, and had found no inconvenience. He remembered the photograph in Zeiss's catalogue, and agreed that the figure viewing the Microscope looked very uncomfortable. As to the precisely best method of focusing from a distance, he thought Mr. Nelson was wrong in supposing there was only one really good method. He had used a Hooke's joint for focusing in Zeiss's photographic room at Jena on several occasions, the illumination being an arc lamp, and projecting the images on a distant screen, and he found it quite convenient. He had tried a number of pulley arrangements, most of which had seemed to him fairly efficient. Excellent work could be done with very various means. No one had exhibited better work than Mr. Thomas Comber, who used a Zeiss Microscope, and who sat down while adjusting the instrument, as would be seen in the woodcuts that would be published in the August Journal. It should be remembered that Mr. Pringle had had the advantage of knowing Mr. Nelson's apparatus and methods, so that any variations he had devised were considered by him as improvements. He was sorry Mr. Pringle was not present to meet Mr. Nelson's criticism.

The Chairman said Mr. Nelson had criticized the new apparatus in his characteristic manner. He thought the subject had taken up as much time as could well be allowed, considering the other matters on the Agenda. He would, therefore, not ask any one to continue the discussion, but would at once call upon the meeting for a vote of thanks to Mr. Andrew Pringle for sending the apparatus for exhibition, and to Mr. Mayall for the description he had given of it.

Mr. E. M. Nelson exhibited upon the screen two photographs of bordered pits of pine wood, taken from sections prepared and mounted by Mr. Suffolk. He thought these pictures showed clearly that the pits were of the nature of clack-valves, and probably served the purpose of checking the downward pressure of fluid in the vascular system, which, in the case of a tree 150 feet high, would amount to about 75 lb. to the square inch. He also showed some new photographs of diatoms × 1350.

Mr. Mayall said a paper had been received from Mr. Charles E. West, of Brooklyn, on "Early Binocular Instruments." After giving a summary of the contents, he pointed out that the paper was rather remarkable for the omission from it of any allusions to binocular instruments of earlier date than Rheita's 'Oculus Enoch et Æliæ, sive Radius Siderio Mysticus,' published in 1645. The modern text-books of the history of physics, &c.—such as Grant's 'History of Physical Astronomy,' or Poggendorff's 'Geschichte der Physik,' or Harting's 'Das Mikroskop'—all referred to the official documents discovered at La Haye in the early part of the century by Van Swinden, whence it was proved that upon Lippershey's pressing for a money recognition from the States General in 1608, for his newly-constructed telescope, the payment was deferred until he could perfect the instrument by making it available as a binocular, which he did before the end of the same year. Then, as to the invention of binocular Microscopes, their American friend was content to quote from Zahn's 'Oculus Artificialis Teledioptricus, sive Telescopium,' published in 1685, apparently oblivious that Zahn was not an original authority on the matter, but that he had roughly summarized from Chérubin

d'Orléans' 'La Vision Parfaite,' published in 1677, where the inventor of the instrument figured and described it in full detail. He (Mr. Mayall) had dealt with the subject somewhat fully in his Cantor Lectures in 1885, and had given a photozincograph from the original figure, and he exhibited the original work to the meeting. He thought, therefore, it would be unnecessary to give any extended publication to Mr. West's notes, especially in view of the fact that twelve pages of the MS. were devoted to translations of passages relating to the binocular telescope, whilst little more than a page was devoted to those on the binocular Microscope.

The Chairman thought that without the reproduction of the figures, both from Chérubin d'Orléans' work and from the first and second editions of Zahn's work, the subject could not be thoroughly explained. In Harting's 'Das Mikroskop' several figures were given from Zahn's work, in some of which two tubes were shown converging in an upright form.

Mr. G. F. Dowdeswell's paper, entitled "A Contribution to the Study of Yeast—No. I. Baker's Yeast," was read by Prof. Bell. Culture-tubes containing specimens illustrative of the subject were handed round for inspection.

The thanks of the Society were given to Mr. Dowdeswell for his communication.

Mr. C. D. Sherborn read some portions of a paper which had been prepared by himself, conjointly with Mr. H. W. Burrows and the Rev. G. Bailey, on "The Foraminifera of the Red Chalk of Norfolk, Lincolnshire, and Yorkshire." The paper contained a long list of the genera and species described, and was illustrated by numerous drawings.

The Chairman, in moving a vote of thanks to the authors of the paper, said that the Council's sense of the value of the communication might be judged from the fact that they had decided to allow four plates to be prepared in illustration, which was considerably beyond the limit of expense to which they felt justified in going under ordinary circumstances.

The thanks of the Society were voted to Messrs. Sherborn, Bailey, and Burrows for their paper.

The Chairman said he thought that was the largest meeting they had yet had in the month of June. It concluded their meetings for the present session, and they would therefore adjourn until Wednesday, October 15th.

The following Instruments, Objects, &c., were exhibited:—

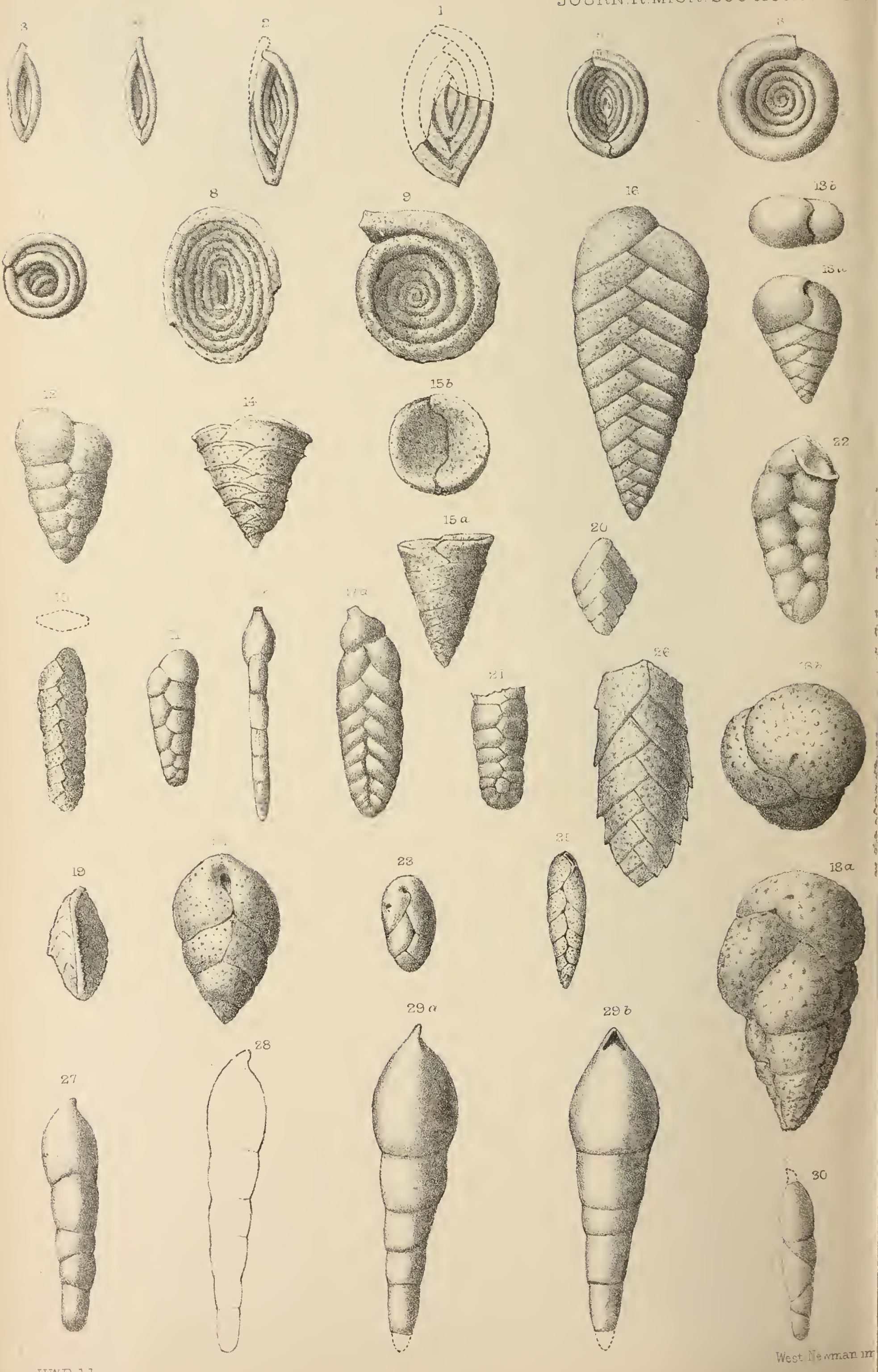
Mr. G. F. Dowdeswell:—Culture-tubes of Micro-organisms from Baker's Yeast.

Mr. E. M. Nelson:—Slides of the Bordered Pits of *Pinus*, and Diatom-structure.

Mr. A. Pringle:—Improved Photomicrographic Apparatus.

Mr. C. Rousselet:—Larval Ascidians, tadpole stage.

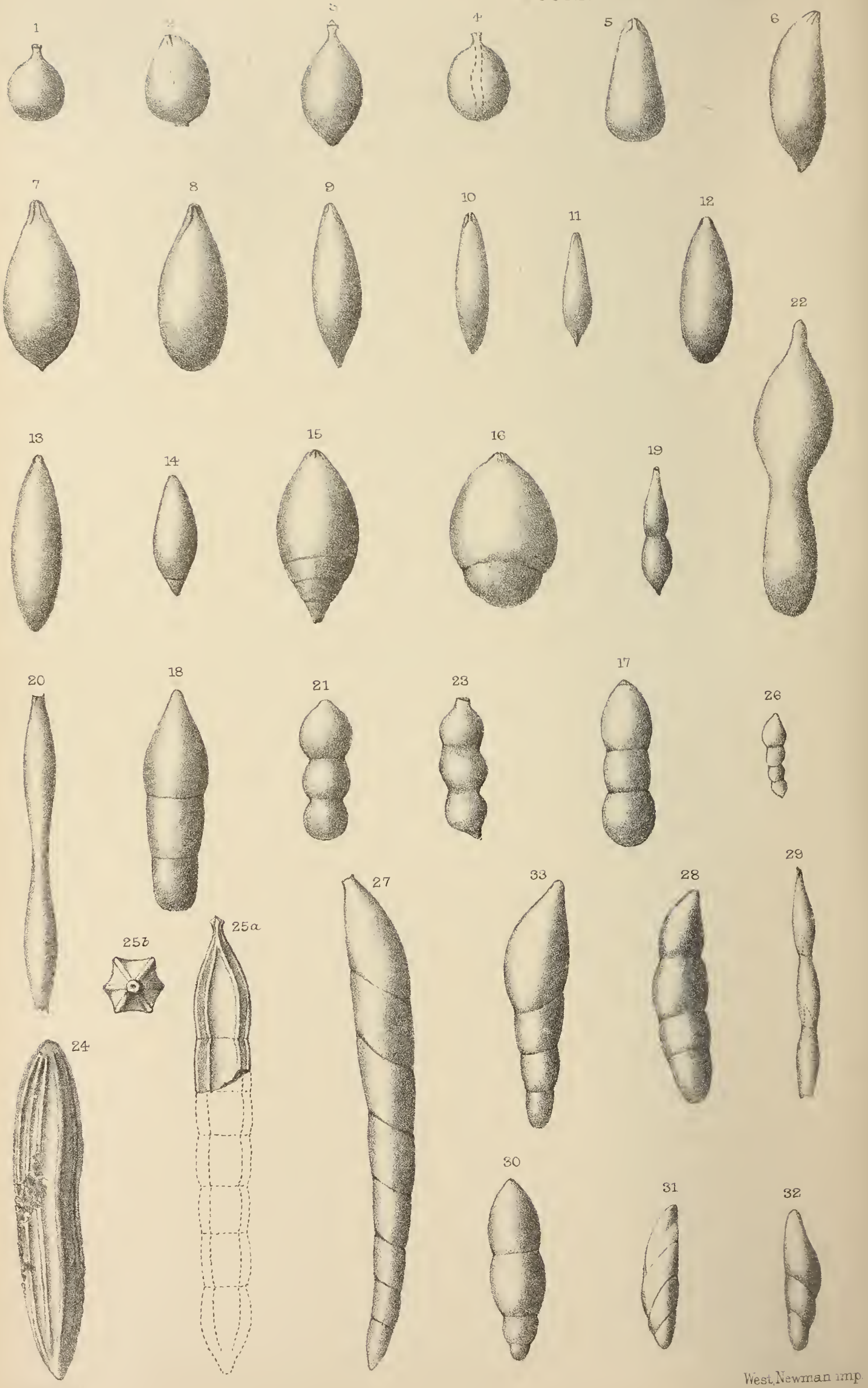
Mr. W. B. Strugnall:—Specimens of *Patella pellucida*.



H.W.B. del.
E.C. Knight lith.

West Newman imp.

Foraminifera of the Red Chalk.



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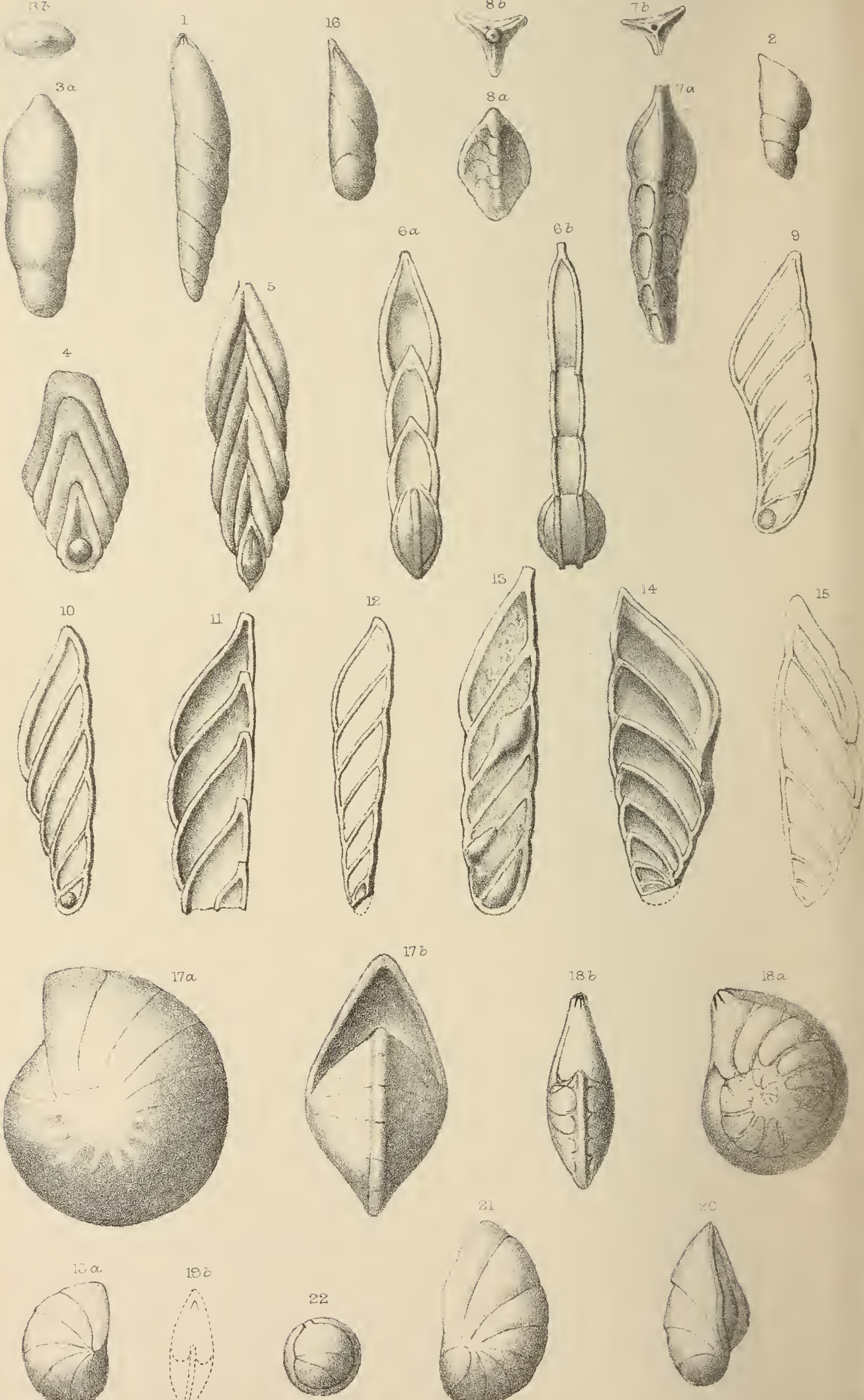
West, Newman imp.

Foraminifera of the Red Chalk



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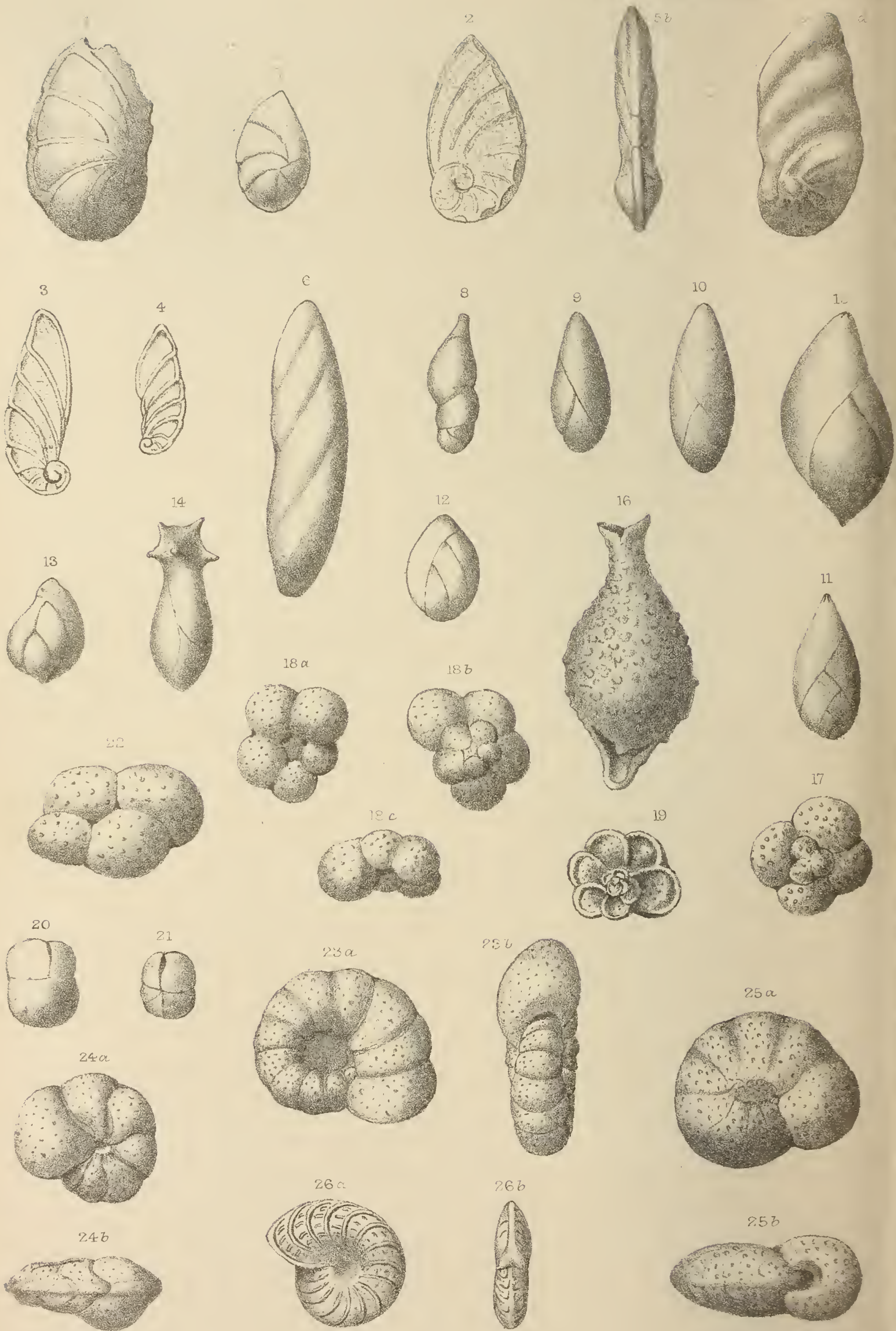
E C Knight lith

West Newman imp.

Foraminifera of the Red Chalk



H.W.B. del.
F.C. Knight lith.

West Newman imp.

Foraminifera of the Red Chalk.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1890.

TRANSACTIONS OF THE SOCIETY.

VIII.—*The Foraminifera of the Red Chalk of Yorkshire, Norfolk, and Lincolnshire.*

By H. W. Burrows, C. Davies Sherborn, and the Rev. Geo. Bailey.

(*Read* 18*th June*, 1890.)

Plates VIII. to XI.

In 1888 we communicated to this Journal (p. 383) a provisional list of Foraminifera from the Red Chalk, promising a memoir on the subject later. It is now our privilege to redeem this promise and further to

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LIST OF FORMS RECORDED AND EXPLANATION OF PLATES.

Plate VIII.

Fig.
1.—*Spiroloculina papyracea* sp. n. × 50.
2. „ *tenuis* (Czjz.) × 50.
3, 4.—*Miliolina* sp. × 50.
5, 6.—*Cornuspira cretacea* Reuss × 50.
7.—*Ammodiscus gordialis* (J. & P.) × 50.
8. „ *incertus* (d'Orb.) × 50.
9. „ *tenuis* Brady × 50.
10.—*Textularia attenuata* Reuss × 75.
11. „ *pygmæa* Reuss × 50.
12. „ *agglutinans* d'Orb. × 50.
13. „ *gramen* d'Orb. × 50.
14. „ *trochus* d'Orb. × 50.
15*a*, *b*. „ *turris* d'Orb. × 50.
16. „ *complanata* Reuss × 50.
17*a*, *b*.—*Textularia* sp. (cf. fig. 10) × 50.
18*a*, *b*.—*Verneuilina propinqua* Brady × 50.
19, 20. „ *triquetra* (v. M.) × 50.
21.—*Spiroplecta biformis* (P. & J.) × 50.
22.—*Gaudryina pupoides* d'Orb. × 50.
23.—*Bulimina affinis* d'Orb. × 75.
24. „ *Presli* Reuss × 50.
25.—*Bolivina textularioides* Reuss × 50.
26. „ *Beyrichi* Reuss v. *alata* Seg. × 50.
„ sp. (not figured).
27, 28, 29*a*, *b*.—*Pleurostomella subnodosa* Reuss × 50.
30. „ *alternans* Schwager × 75.

Plate IX.

Fig.
1, 2, 4.—*Lagena globosa* (Mont.) × 50.
3. „ *lævis* (Mont.) × 50.
6, 7, 9, 10, 11. „ *apiculata* Reuss × 50.
8, 12, 13. „ „ v. *emaciata* Reuss × 50.
5. „ *cincta* Seguenza × 50.
14, 15.—*Nodosaria* (*Glandulina*) *lævigata* d'Orb. × 50.
16. „ „ *obtusissima* Reuss × 50.
17. „ „ *cylindrica* Reuss × 50.
18. „ „ *candela* Egger × 50.
19.—*Nodosaria simplex* Silvestri × 75.
20. „ *longiscata* d'Orb. × 50.

illustrate our remarks by a series of plates generously granted to us by the Royal Microscopical Society.

The material contributing to this paper has been derived from six sources.

(1) A small collection made by C. D. Sherborn from material carefully selected from the softer band of the Red Chalk at Hunstanton by Mrs. R. E. May. These specimens are of minute size.

(2) A large collection made by H. W. Burrows, from material obtained from the upper portion of the Red Chalk at Speeton, kindly

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PLATE IX.—*continued.*

Fig.
21.—*Nodosaria calamorpha* Reuss × 50.
22. „ sp. × 50.
23. „ *limbata* d'Orb. × 50.
24. „ *obscura* Reuss × 40.
25*a*, *b*. „ *prismatica* Reuss × 50.
26. „ (*Dentalina*) *soluta* Reuss × 100.
27. „ „ *communis* d'Orb. × 50.

Fig.
28.—*Nodosaria* (*Dentalina*) *brevis* d'Orb. × 50.
29. „ „ *filiformis* d'Orb. × 50.
30. „ „ *marginulinoides* Reuss × 50.
31. „ „ *mucronata* Neugeboren × 50.
32. „ „ *abnormis* Reuss × 75.
33.—*Marginulina inæqualis* Reuss × 50.

PLATE X.

Fig.
1.—*Marginulina glabra* d'Orb. × 50.
2. „ *variabilis* Neugeboren × 50.
3*a*, *b*.—*Lingulina carinata* d'Orb. × 50.
4.—*Frondicularia biformis* Marsson × 50.
5. „ *gaultina* Reuss × 25.
6*a*, *b*. „ *Archiaciana* d'Orb. × 50.
7*a*, *b*.—*Rhabdogonium tricarinatum* (d'Orb.) × 50.
8*a*, *b* „ *minutum* Reuss × 75.
9.—*Vaginulina eurynota* Reuss × 25.

Fig.
10, 11, 12, 13.—*Vaginulina recta* Reuss × 50.
14, 15. „ *arguta* Reuss × 50.
16. „ *legumen* (Linn.) × 75.
„ sp. (not figured).
17*a*, *b* (and XI. 7) *Cristellaria rotulata* (Lam.) × 50.
18*a*, *b*. „ *cultrata* (Montf.) × 50.
19*a*, *b*, 21. „ *gibba* d'Orb. × 50.
20. „ *italica* (Defr.) × 50.
22 (and XI. 8) „ *variabilis* Reuss × 50.

PLATE XI.

Fig.
1.—*Cristellaria lata* Reuss × 50.
2. „ *multiseptata* (F. & M.) × 50.
3, 4. „ *crepidula* (F. & M.) × 50.
5*a*, *b*. „ *Marckii* Reuss × 50.
6. „ *cymboides* d'Orb. × 50.
9, 10.—*Polymorphina lactea* (W. & J.) × 50.
11. „ *communis* d'Orb. × 50.
12, 13. „ *amygdaloides* Reuss *vel* *P. gibba* d'Orb. × 50.
14, *h* „ *horrida* Reuss × 75.
15. „ sp. × 50.
Uvigerina sp. (not figured). × 50.
16.—*Ramulina aculeata* (d'Orb.) × 50.

Fig.
17.—*Globigerina bulloides* (d'Orb.) × 50.
18*a*, *b*, *c*. „ *cretacea* (d'Orb.) × 50.
19. „ *Linnæana* (d'Orb.) × 75.
Orbulina universa d'Orb. (not figured).
20, 21.—*Sphæroidina bulloides* d'Orb. × 75.
22.—*Truncatulina variabilis* d'Orb. × 50.
23*a*, *b*.—*Planorbulina ammonoides* (Reuss) × 50.
Pulvinulina Menardii (d'Orb.) (not figured).
24*a*, *b*.—*Discorbina* vel *Truncatulina* × 50.
25*a*, *b*.—*Anomalina grosserugosa* (Gümb.) × 50.
26*a*, *b*.—*Polystomella macella* (F. & M.) × 50.

(Some of these specimens have been deposited in the Natural History Museum.)

supplied by Mr. J. T. Day, F.G.S., who also suggested the method of disintegrating the hard material which is described in the footnote.*

Many of the specimens obtained are gigantic in comparison with those from the same and other localities.

(3) A still larger collection of balsam-mounted slides of material from Speeton, disintegrated and prepared by the Rev. G. Bailey. The greater part of this material was obtained from a deep-red band about two miles east of Speeton Gap, and near the boundary line of Buckton and Bempton parishes. It was collected at extreme low water during spring tides, at which time the bed is most conveniently exposed.

(4) A large collection of sliced Red Gaults and Red Chalks from various localities in Norfolk, Yorkshire, and Lincolnshire, kindly placed at our disposal by Mr. W. Hill, jun., F.G.S.

(5) Three slides of balsam-mounted dust from the Red Chalk of Flamborough Head † lent to us by Dr. H. B. Brady, F.R.S.

(6) A slide of dust, also balsam-mounted, by the favour of Dr. Clifton Sorby, F.R.S.

We have also availed ourselves of the published records of the Rev. T. Wiltshire, Messrs. Parker, Jones, Blake, and Whitaker, details of which will be found in our previous note.

SPIROLOCULINA d'Orbigny, 1826.

Spiroloculina papyracea sp. n., plate VIII. fig. 1.—The lower half of a thin and much compressed form from the red chalk of Flamborough Head. The nearest figures to this which have come under our notice are *Spiroloculina* sp. (Hantken, Mitth. Jahrb. k. ung. Geol. Anst., iv. 1875, plate xiii. fig. 1) and *S. Freyeri* (Reuss, Denkschr. k. Ak. Wiss. Wien, xxiii. 1864, plate i. fig. 9), of which the former shows rounded chambers, and the latter is referable to *S. planulata* d'Orb. We have therefore ventured to record it under a new specific name. Dr. Brady's Coll.

S. tenuis (Czjz.) plate VIII. fig. 2. *Quinqueloculina tenuis* Czjzek, Haidinger's Nat. Abh., ii. 1848, p. 149, plate xiii. fig. 31–34; *S. tenuis*, Brady, Rep. Challenger, ix. 1884, p. 152, plate x. fig. 9. One specimen (Canada balsam, Bailey Coll.) is referable to this form: the outer chamber has been crushed and displaced.

* Owing to its great hardness, the separation of the Foraminifera from the Red Chalk is always difficult. The following method, however, greatly simplifies the process:—Break up the chalk into small pea-sized fragments, and boil in strong solution of sulphate of soda till reduced to powder; wash till all muddiness is removed.

† Speeton or Buckton. This applies also to the "Flamborough Head" of Emmett, these being the nearest places to Flamborough Head at which the red chalk crops out. (See Parker and Jones, 'Geologist,' 1860, p. 419.)

Miliolina Williamson, 1858.

Miliolina sp., plate VIII. figs. 3, 4.—Two characteristic examples of a triloculine form occurring at rare intervals in Mr. Bailey's preparations. We are not at all sure that these do not represent younger stages of *Spiroloculina tenuis* (*supra*), but as only one specimen, by reason of the number of its chambers, can be truly referred to that genus, we hesitate either to place these with it, or to impose upon them a new specific name.

Cornuspira Schultze, 1854.

Cornuspira cretacea Reuss, plate VIII. figs. 5, 6. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 177, plate i. figs. 1*a*, *b*.—Occurs frequently at Speeton. The individuals vary in shape from circular to oval, as shown in the figures, but all possess the true characters of the "species." Several have either grown irregularly or have been injured since being deposited, for they show a depressed line from margin to margin, and appear at first sight to belong to *Spiroloculina*.

Ammodiscus Reuss, 1861.

Ammodiscus gordialis (Jones & Parker), plate VIII. fig. 7. *Trochammina gordialis* Jones & Parker, Quart. Journ. Geol. Soc., xvi. 1860, p. 304. *A. gordialis*, Brady, Rep. Challenger, ix. 1884, p. 333, plate xxxviii. figs. 7–9.—Two specimens of this interesting foraminifer occur in Mr. Burrows' washings. In one example the tube is thickened by subsequent deposition into an apparently solid boss in the centre.

A. incertus (d'Orbigny), plate VIII. fig. 8. *Operculina incerta*, d'Orb. in De la Sagra's Hist. Ile Cuba, 1839, Foram., p. 49, plate vi. figs. 16, 17; *A. incertus*, Brady, Rep. Challenger, ix. 1884, p. 330, plate xxxviii. figs. 1–3.—Several specimens of this variable form occur in Mr. Bailey's preparations.

A. tenuis Brady, plate VIII. fig. 9. Brady, Rep. Challenger, ix. 1884, p. 332, plate xxxviii. figs. 4–6. — This foraminifer, of which only one example was found, agrees so closely with Brady's figure that we do not hesitate to record it as such; at the same time we endorse Dr. Brady's remark, "that it is probably nothing more than a local variety of *A. incertus*." Bailey Coll.

Textularia Defrance, 1824.

Textularia attenuata Reuss, plate VIII. fig. 10. Reuss, SB. k. Ak. Wiss. Wien, xlviii. (i.) 1863, p. 59, plate vii. fig. 87.—Reuss figures and describes this species from the Septarienthon, and states that it is very variable in shape. Our specimen agrees with his figure, except that it has fewer chambers. One specimen, Bailey Coll.

T. pygmæa Reuss, plate VIII. fig. 11. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (i.) 1862, p. 80, plate ix. fig. 11.—Described by Reuss from

the *Minimus*-Thon of the North German gault. The specimen figured comes from Hunstanton (Sherborn Coll.), and is the only one met with. Jones and Parker record this species as "common" in the Emmett collection, from Flamborough Head.

T. agglutinans d'Orb., plate VIII. fig. 12. D'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, p. 144, plate i. figs. 17, 18, 32–34.—Occurs rarely in our collections; the specimen figured is from Mr. Burrows' washings.

T. gramen d'Orb., plate VIII. figs. 13*a*, *b*. D'Orbigny, Foram. Foss. Vienne, 1846, p 248, plate xv. figs. 4–6.—One specimen, Burrows Coll.

T. trochus d'Orb., plate VIII. fig. 14. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 45, plate iv. figs. 25, 26.—Common in Mr. Bailey's preparations. The chambering in all the specimens is obscure, and can only be made out by careful study.

T. turris d'Orb., plate VIII. figs. 15*a*, *b*. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 46, plate iv. figs. 27, 28.—This form seems rare in the red chalk; Hunstanton (Sherborn Coll.); Speeton (Bailey Coll.).

T. complanata (Reuss), plate VIII. fig. 16. *Proroporus complanatus*, Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 231, plate xii. figs. 5 *a*, *b*.—This interesting textularian occurs abundantly in Mr. Burrows', but more sparingly in Mr. Bailey's preparations. The specimens vary from Reuss' type, in that they are shorter and broader and have fewer chambers.

Textularia sp., plate VIII. figs. 17*a*, *b*.—One specimen only of a textularian with a bladder-like final chamber, the orifice being produced into a snout; Burrows Coll. Dr. Brady informs us that this anomalous condition is occasionally met with, and therefore the character is not specific. It is probably a well-developed specimen of Reuss's *T. attenuata* (*supra*).

Verneuilina d'Orbigny, 1840.

Verneuilina propinqua Brady, plate VIII. figs. 18*a*, *b*. Brady, Rep. Challenger, ix. 1884, p. 387, plate xlvi. figs. 9, 10.—Specimens of *Verneuilina* in Mr. Burrows' collection show so strong a resemblance to Dr. Brady's species that we do not hesitate to refer them to that form. In the figure the mouth is perhaps a little accentuated, the tenacious adherence of the matrix making it difficult to ensure the absolute freedom of the specimens.

V. triquetra (Münster), plate VIII. figs. 19, 20. *Textularia triquetra* v. Münster in Roemer, Neues Jahrb., 1838, p. 384, plate iii. fig. 19: *V. triquetra*, Brady, Rep. Challenger, ix. 1884, p. 383, plate xlvii. figs. 18–20.—Extremely common in Mr. Bailey's preparations, but often obscure and difficult to determine. We have, however, no doubt as to its identity. In many cases, possibly from its extra-

transparency, this form has the appearance of a textularian, and occasionally (see fig. 20) resembles closely Reuss's *Polymorphina subrhombica* (SB. k. Ak. Wiss. Wien, xliv. 1861, p. 339, plate vii. fig. 3), from the Senonian of New Jersey, in general shape and appearance. It is likely, too, that Marsson's *Bolivina tenuis* (Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 126, plate iii. fig. 23*b*) is this form, as also *B. tenuis* Marss. as figured by Tutkovskiī (Zap. Kievsk. Obsch. Estest., vii. 1887, p. 350, plate viii. fig. Γ), for both these figures were drawn from balsam-mounted specimens, in which medium false appearances are very apt to occur.

Spiroplecta Ehrenberg, 1844.

Spiroplecta biformis (Parker & Jones), plate VIII. fig. 21. *Textularia agglutinans* v. *biformis*, Parker & Jones, Phil. Trans., 1865, p. 370, plate xv. figs. 23, 24; *S. biformis*, Brady, Rep. Challenger, ix. 1884, p. 377, plate xlv. figs. 25–27.—A few examples have been met with in Mr. Bailey's preparations. Parker and Jones record it from the Gault and Chalk in their paper quoted above; the species occurs also in a section of Red Chalk from Speeton, and in another of Gault from Roydon, both in Mr. W. Hill's collection.

Gaudryina d'Orbigny, 1840.

Gaudryina pupoides d'Orb., plate VIII. fig. 22. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 44, plate iv. figs. 22–24; Brady, Rep. Challenger, ix. 1884, p. 378, plate xlvi. fig. 2.—One large individual, Burrows Coll.

Bulimina d'Orbigny, 1826.

Bulimina affinis d'Orb., plate VIII. fig. 23. D'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, p. 105, plate ii. figs. 25, 26; Brady, Rep. Challenger, ix. 1884, p. 400, plate l. figs. 14 *a*, *b*.—Common in Mr. Bailey's preparations. From its minute size, it has probably escaped observation when searching dry material from the same and other localities.

B. Presli Reuss, plate VIII. fig. 24. Reuss, Verst. böhm. Kreide, part i. 1845, p. 38, plate xiii. fig. 72, and Haidinger's Nat. Abh., iv. (i.) 1851, p. 39, plate iii. fig. 10.—One of the most common forms in the red chalk as in other cretaceous deposits, occurring often of a considerable size.

Bolivina d'Orbigny, 1839.

Bolivina textularioides Reuss, plate VIII. fig. 25. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (i.), 1862 (1863), p. 81, plate x. figs. 1 *a*, *b*.—Abundant but small in Mr. Bailey's slides. Described by Reuss from the middle Hils-Thon of north-west Germany.

B. Beyrichi Reuss, plate VIII. fig. 26. Reuss, Zeitschr. deutsch.

geol. Ges., iii. 1851, p. 83, plate vi. fig. 51.—Fragments of Seguenza's variety *alata* * are frequently met with in Mr. Bailey's preparations.

Bolivina sp. A third species of this genus is common in Mr. Bailey's slides. Apparently near to *B. punctata* d'Orb., but the difficulty of determining balsam-mounted specimens prevents us from doing more than recording its presence.

Pleurostomella Reuss, 1859.

Pleurostomella subnodosa Reuss, plate VIII. figs. 27, 28, 29 *a, b*. *Dentalina subnodosa* Reuss, Verst. böhm. Kreide, part i. 1845, p. 28, plate xiii. fig. 22. *P. subnodosa* Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 204, plate viii. figs. 2 *a, b*.—Nine examples, the characteristic variation of which is well shown in the specimens selected for illustration. The rapidly increasing form (fig. 29) is the more common, that shown in fig. 27 approaches *P. alternans*. Burrows Coll.

P. alternans Schwager, plate VIII. fig. 30. Schwager, Novara Reise, 1866, p. 238, plate vi. fig. 80.—A small specimen, the last chamber of which is possibly imperfect. Bailey Coll.

Lagena Walker & Boys, 1784.

Lagena globosa (Mont.), plate IX. figs. 1, 2, 4. *Vermiculum globosum* Montagu, Test. Brit., 1803, p. 523; *L. globosa* Brady, Rep. Challenger, ix. 1884, p. 452, plate lvi. figs. 1–3.—Rare in our washings. Some of the specimens show the entosolenian neck. Bailey preparations.

L. lævis (Mont.), plate IX. fig. 3. *Vermiculum læve* Montagu, Test. Brit., 1803, p. 524: *L. lævis* Brady, Rep. Challenger, ix. 1884, p. 455, plate lvi. figs. 7–14, 30.—One specimen; the closing of the aperture is probably due to matrix. Burrows Coll.

L. apiculata Reuss, plate IX. figs. 6, 7, 9, 10, 11. *Oolina apiculata* Reuss, Haidinger's Nat. Abh., iv. (i.) 1851, p. 22, plate i. fig. 1; *L. apiculata* Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 319, plate i. figs. 4–8, 10, 11; Brady, Rep. Challenger, ix. 1884, p. 452, plate lvi. figs. 4, 15–18.—Most abundant and very variable in shape, a condition characteristic also of its living representatives.

L. apiculata var. *emaciata* Reuss, plate IX. figs. 8, 12, 13. *L. emaciata* Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 319, plate i. fig. 9.—Numerous specimens occur in Mr. Burrows' collection. It can scarcely be separated from the foregoing, and Reuss says of it, "der wesentliche Unterschied liegt in dem völligen Mangel des Centralstachels an der Basis des Gehäuses."

L. cincta Seguenza, plate IX. fig. 5. *Fissurina cincta* Seguenza, Foram. Monotal. Messina, 1862, p. 62, plate ii. fig. 31.—One specimen

* *Vulvulina alata* Seg., Atti Acc. Gioenia, [2] xviii. 1862, p. 115, pl. ii. f. 5; *B. Beyrichi* v. *alata* Seg., Brady, Rep. Challenger, ix. 1884, p. 422, pl. liii. figs. 2–4.

only (Bailey Coll.) of this curious compressed Lagena, previously described by Seguenza, with a fissurine aperture, from the Miocene of Messina.

NODOSARIA Lamarck, 1816.

(GLANDULINA d'Orbigny, 1826.)

Nodosaria (*Glandulina*) *lævigata* d'Orb., plate IX. figs. 14, 15. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 252, No. 1, plate x. figs. 1–3; Brady, Rep. Challenger, ix. 1884, p. 490, plate lxi. figs. 17–22.—Rare at Speeton, the specimen figured is in the Burrows Coll.

N. (*G.*) *obtusissima* Reuss, plate IX. fig. 16. Reuss, SB. k. Ak. Wiss. Wien, xlviii. 1863, p. 66, plate viii. fig. 92; Sherborn & Chapman, Journ. R. Micr. Soc., 1886, p. 746, plate xiv. fig. 21.—One specimen, Burrows Coll.

N. (*G.*) *cylindracea* Reuss, plate IX. fig. 17. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 190, plate iv. fig. 1: also figured as *N. glandulinoides* = *Geinitziana*, by Neugeboren, Verh. Mitth. Siebenbürg. Ver. Nat., iii. 1852, p. 37, plate i. fig. 2, and ibid., xi. 1860, p. 55, etc.; and as *N. parvula* by Dunikowski, from the Lemberg Chalk, Kosmos (Lwow), iv. 1879, p. 107, plate, fig. 6.—One specimen, Burrows Coll.

N. (*G.*) *candela* Egger, plate IX. fig. 18. Egger, Neues Jahrb., 1857, p. 304, plate xv. fig. 28.—Described by Egger from the Miocene of Ortenburg, Lower Bavaria. In his figure the second chamber is slightly smaller than the first, otherwise our specimen corresponds with it exactly. Burrows Coll.

(NODOSARIA.)

N. simplex Silvestri, plate IX. fig. 19. Silvestri, Atti Acc. Gioenia, vii. 1872, p. 95, plate xi. figs. 268–272; Brady, Rep. Challenger, ix. 1884, p. 496, plate lxii. figs. 4–6.—Of rare occurrence in our washings. This = *N. oligostegia* Reuss, referred to in our earlier list (this Journal, 1888, p. 384).

N. longiscata d'Orb., plate IX. fig. 20. D'Orbigny, Foram. Foss. Vienne, 1846, p. 32, plate i. figs. 10–12; Brady, Quart. Journ. Geol. Soc., xliv. 1888, p. 6.—One fragment, Burrows' collection. Dr. Brady has cleared up the doubt as to the exact shape of d'Orbigny's original specimens in the paper referred to above.

N. calamorpha Reuss, plate IX. fig. 21. Reuss, Denkschr. k. Ak. Wiss. Wien, xxv. 1865, p. 129, plate i. fig. 18. See also *Glandulina crassa* Dunikowski, Kosmos (Lwow), iv. 1879, p. 122, plate, p. 14, from the chalk of Lemberg.—This and similar forms figured on plate IX. are all closely allied to *N. radicula* Linn., which has been met with by us, only in a varietal form at Hunstanton (Sherborn), but as trivial names have been given to them, we repeat them here for convenience of classification and reference.

Nodosaria sp., plate IX. fig. 22.—Apparently a very coarsely grown variety of *N. calamorpha.* A similar form was figured by Soldani as "*Orth. perfecte globularia,*" Saggio Oritt., 1780, p. 108, plate vi. fig. G, *g.*

N. limbata d'Orb., plate IX. fig. 23. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 12, plate i. fig. 1. Hunstanton, Sherborn Coll. Gümbel's *N. granito-calcarea*, Abh. k. bay. Ak. Wiss. (cl. ii.) x. (2) p. 613, plate i. fig. 19, apparently belongs to this form.

N. obscura Reuss, plate IX. fig. 24. Reuss, Verst. böhm. Kreide, part i. 1845, p. 26, plate xiii. fig. 8.—This figure is a much restored drawing of a damaged specimen in Mr. Burrows' collection. The sutures are not shown as they are quite indistinguishable in the original. Since the figure was drawn two or three more perfect specimens have been found by Mr. Bailey at the same locality (Speeton).

N. prismatica Reuss, plate IX. fig. 25 *a, b.* Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 180, plate ii. fig. 2.—Two upper chambers of a specimen so exactly corresponding to Reuss's type that we have ventured to restore the missing portion by a dotted outline traced from Reuss's figure. Burrows Coll.

Dentalina d'Orbigny, 1826.

N. (*Dentalina*) *soluta* Reuss, plate IX. fig. 26. Reuss, Zeitschr. deutsch. geol. Ges., iii. 1851, p. 60, plate iii. fig. 4.—A small but perfect individual, from Mr. Bailey's preparations.

N. (*D.*) *communis* d'Orb., plate IX. fig. 27. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 254, No. 35; Brady, Rep. Challenger, ix. 1884, p. 504, plate lxii. figs. 19–22.—Common. Recorded by Jones and Parker from Flamborough Head (Emmett Coll.).

N. (*D.*) *brevis* d'Orb., plate IX. fig. 28. D'Orbigny, Foram. Foss. Vienne, 1846, p. 48, plate ii. figs. 9, 10.—One specimen, Burrows Coll.

N. (*D.*) *filiformis* d'Orb., plate IX. fig. 29. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 253, No. 14; Brady, Rep. Challenger, ix. 1884, p. 500, plate lxiii. fig. 4.—Three chambers of a specimen occurring in one of Mr. Bailey's slides is here figured.

N. (*D.*) *marginuloides* Reuss., plate IX. fig. 30. Reuss, Haidinger's Nat. Abh., iv. (i.) 1850, p. 25, plate ii. (i.) fig. 12.—Closely allied to *D. brevis;* figured by Reuss from the chalk of Lemberg. One specimen, Bailey Coll.

N. (*D.*) *mucronata* Neugeboren, plate IX. fig. 31. Neugeboren, Denkschr. k. Ak. Wiss. Wien, xii. (2) 1856, p. 83, plate iii. figs. 8–11; Brady, Rep. Challenger, ix. 1884, p. 505, plate lxii. figs. 27–29.—A few specimens of this variety occur in Mr. Bailey's preparations.

N. (*D.*) *abnormis* Reuss, plate IX. fig. 32. Reuss, SB. k. Ak. Wiss. Wien, xlviii. 1863, p. 46, plate ii. fig. 24.—Bailey Coll.

Marginulina d'Orbigny, 1826.

Marginulina glabra d'Orb., plate X. fig. 1. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 259, No. 6; Brady, Rep. Challenger, ix. 1884, p. 527, plate lxv. figs. 5, 6.—One specimen, Bailey Coll.

M. inequalis Reuss, plate IX. fig. 33. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 207, plate vii. fig. 3.—Reuss figures this from the chalk of Westphalia. One example, Burrows Coll.

M. variabilis Neugeb., plate X. fig. 2. Neugeboren, Verh. Mitth. Siebenbürg. Ver. Nat., ii. 1851, p. 133, plate v. figs. 10–14 (including *M. Ackneriana*, *M. erecta*, and *M. intermedia* Neugeboren, ibid., xi. 1860, p. 55, etc.).—Abundant in the rich tertiary deposits of Felső-Lapugy, Hungary. Occurring rarely in Mr. Bailey's preparations.

Lingulina d'Orbigny, 1826.

Lingulina carinata d'Orb., plate X. figs. 3 *a*, *b*. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 257, No. 1; Brady, Rep. Challenger, ix. 1884, p. 517, pl. lxv. figs. 16, 17.—One specimen from Hunstanton (Sherborn), now in the Geological Collection, Science Schools, South Kensington. Reuss figured this foraminifer from the chalk of Bohemia under the name of *L. bohemica* (Verst. böhm. Kreide, part 2, 1846, p. 108, plate viil. (xliii.) fig. 10) and also as *L. nodosaria* from the Speeton clay of Spectsbrink (SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 59, plate v. fig. 12). We have also seen it in a slice of red gault from Hersingham lent to us by Mr. W. Hill, F.G.S.

Frondicularia Defrance, 1824.

Frondicularia biformis Marsson, plate X. fig. 4. Marsson, Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 137, plate ii. fig. 17.—One specimen, Burrows Coll.

F. gaultina Reuss, plate X. fig. 5. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 190, plate v. fig. 5.—One example, Burrows Coll.

F. Archiaciana d'Orb., plate X. figs. 6 *a*, *b*. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 20, plate i. figs. 34–36.—We regard this as referable to d'Orbigny's form. Reuss figured it from the chalk of Bohemia under the name of *F. bicuspidata* (Verst. böhm. Kreide, part 1, 1845, p. 32, plate xiii. fig. 46), a varietal form, with which our specimens closely agree. Dunikowski's *F. polonica* (Kosmos [Lwow], iv. 1879, p. 124, plate, fig. 16), from the chalk of Lemberg, belongs also to d'Orbigny's species.

Rhabdogonium Reuss, 1860.

Rhabdogonium tricarinatum (d'Orbigny), plate X. figs. 7 *a*, *b*. *Vaginulina tricarinata* d'Orbigny, Ann. Sci. Nat., vii. 1826, p. 258, No. 4, and Modèles, No. 4; *R. tricarinatum* Brady, Rep. Challenger, ix. 1884, p. 525, plate lxvii. figs. 1–3.—A fine and perfect specimen,

Burrows Coll. This species appears only to have been recorded previously from Tertiary and Recent deposits.

Rhabdogonium, plate X. figs. 8 *a*, *b*.—A small example in Mr. Burrows' collection. The specimen is free from matrix, but the chambering is very obscure. We believe it to be referable to Reuss's *R. minutum*, SB. k. Ak. Wiss Wien, lv. (1) 1867, p. 84, plate v. figs. 4, 5; Brady, Rep. Challenger, ix. 1884, p. 526, plate lxvii. figs. 4–6, but cannot definitely say.

Vaginulina d'Orbigny, 1826.

Vaginulina eurynota Reuss, plate X. fig. 9. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (1) 1863, p. 90, plate xii. figs. 9 *a*, *b*.—Rare at Speeton.

V. recta Reuss (*non* Karrer, 1864), plate X. figs. 10–13. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (1) 1863, p. 48, plate iii. figs. 14, 15. Frequent, Burrows Coll. A variety of this form is given at fig. 11, and differs from it in the ornamentation produced by the mouths of each succeeding chamber.

V. arguta Reuss, plate X. figs. 14, 15. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 202, plate viii. fig. 4. Rare, at Speeton.

V. legumen (Linn.), plate X. fig. 16. *Nautilus legumen* Linnæus, Syst. Nat. ed. 12, 1767, p. 1164; Brady, Rep. Challenger, ix. 1884, p. 530, plate lxvi. fig. 14.*—Several specimens, Bailey Coll.

Vaginulina (immature).—Numerous similar examples of elongate nodosarian forms occur in Mr. Bailey's preparations.

Cristellaria Lamarck, 1816.

Cristellaria rotulata (Lam.), plate X. figs. 17 *a*, *b*, and plate XI. fig. 7. *Lenticulites rotulata*, Lamarck, Ann. du Mus., v. 1804, p. 188, and viii. 1806, plate lxii. fig. 11; *C. rotulata* Brady, Rep. Challenger, ix. 1884, p. 547, plate lxix. fig. 13.—Common, but the figured specimen in Mr. Burrows' collection is gigantic as compared with the others. Jones and Parker record it from Flamborough Head (Emmett Coll.), and Wiltshire figures it from Hunstanton.

C. cultrata (Montf.), plate X. figs. 18 *a*, *b*. *Rotulus cultratus* Montfort, Conch. Syst., i. 1808, p. 215, genre 54; *C. cultratus* Brady, Rep. Challenger, ix. 1884, p. 550, pl. lxx. figs. 4–8.—One fine specimen only, Burrows Coll. Doubtless many of the small specimens in Mr. Bailey's preparations belong to this species, but they are too immature for determination.

C. gibba d'Orb., plate X. figs. 19 *a*, *b*, 21. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 292; and in De la Sagra's Hist. Ile Cuba, 1839, p. 40, plate vii. figs. 21, 22.—One example, Bailey Coll.

* See also Fornasini, Boll. Soc. Geol. Ital., v. 1886, p. 25, pl. i., where the life-history of the typical form is traced and figured.

C. italica (Defrance), plate X. fig. 20. *Saracenaria italica* Defrance, Dict. Sci. Nat., xxxii. 1824, p. 177, Atlas Conch., plate xiii. fig. 6; *C. italica* Brady, Rep. Challenger, ix. 1884, p. 544, plate lxviii. fig. 17, etc.—Rare in Mr. Bailey's slides.

C. lata Reuss, plate XI. fig. 1. *Rotulina lata* Reuss, SB. k. Ak. Wiss. Wien, xlviii. 1868, p. 52, plate v. fig. 57.—Recorded by Reuss from the Septarienthon of Offenbach. One specimen (Bailey Coll.) is damaged, but preserves enough character to admit of identification.

C. variabilis Reuss, plate X. fig. 22, and plate XI. fig. 8. Reuss, Denkschr. k. Ak. Wiss. Wien, i. 1850, p. 369, plate xlvi. figs. 15, 16; Brady, Rep. Challenger, ix. 1884, p. 541, plate lxviii. figs. 11–16. Reuss's figures give the student little idea of the variability of this species. Brady, more fortunate in working over the 'Challenger' material, was able to trace and figure the life-history, finding individuals of all ages. It is interesting to find in the red chalk an example (fig. 22) of the youngest form figured by Brady. Bailey Coll.

C. multiseptata Reuss, plate XI. fig. 2. Reuss, Haidinger's Nat. Abh., iv. 1850, p. 33, plate ii. fig. 9.—This robust variety of *C. crepidula* was found by Reuss in the chalk of Lemberg. Our drawing is taken from a specimen from Flamborough Head, from a balsam-mounted slide lent to us by Dr. Brady. It is drawn as viewed by transmitted light. *C. multiseptata* differs but little from *C. gibba* d'Orb., and was figured several times by Reuss under different specific names. Of these we may mention *C. recurrens* (Denkschr. k. Ak. Wiss. Wien, xxv. 1865, p. 140, plate ii. fig. 36) and *C. galeata* (ibid., p. 141, plate iii. fig. 8) from the German Septarienthon. Marsson's *C. foliacea* (Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 143, plate ii. fig. 18) also belongs to this form.

C. crepidula (F. & M.), plate XI. figs. 3, 4. *Nautilus crepidula* Fichtel & Moll, Test. micros., 1798, p. 107, plate xix. figs. *g–i*; Brady Rep. Challenger, ix. 1884, p. 542, plate lxviii. fig. 1.—Abundant. The two figured are drawn as viewed by transmitted light.

C. Marckii Reuss, plate XI. figs. 5*a*, *b*. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 212, plate ix. fig. 4.—Found by Reuss, but rarely, in the Senonian clays of the Hilgenberges. One specimen, Burrows Coll.

C. cymboides d'Orb., plate XI. fig. 6. D'Orbigny, Foram. Foss. Vienne, 1846, p. 85, plate iii. figs. 30, 31; v. Hantken, Mitth. Jahrb. k. ung. Geol. Anst., iv. 1875, p. 49, plate v. fig. 3.—Although regarded as synonymous with *C. crepidula* this foraminifer has amongst fossil forms some representatives far removed from the neat and elegant type of that species shown by us in fig. 3. One of these representatives, coarsely grown, and with but four chambers, we have figured. It agrees almost precisely with the specimen given by v. Hantken from the *Clavulina Szaboi* Tertiary beds of Hungary.

POLYMORPHINA d'Orbigny, 1826.

Polymorphina lactea (Walker & Jacob), plate XI. figs. 9, 10. *Serpula lactea,* Walker & Jacob in Kannmacher's edition of Adams, Essays Micros., 1798, p. 634; *P. lactea,* Brady, Rep. Challenger, ix. 1884, p. 559, plate lxxi. fig. 11.—Common in the red chalk. The two figured specimens of *P. lactea* v. *elongata* Brady, Rep. Challenger, ix. 1884, p. 559, plate lxxi. fig. 14, are in Mr. Burrows' collection.

P. communis d'Orb., plate XI. fig. 11. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 266, No. 15, plate xii. figs. 1–4.—Not rare. Mr. Bailey's preparations.

P. amygdaloides Reuss, and *P. gibba* d'Orb., plate XI. figs. 12, 13. — Abundant specimens of small *Polymorphinæ* occur in Mr. Bailey's preparations, and can, we believe, be referred to these two forms. As shown in the figures given by Brady, Parker, and Jones (Trans. Linn. Soc., xxvii. plate xxxix., woodcuts p. 215) these forms differ principally in degree of compression; it is therefore difficult to separate them when mounted in Canada balsam.

P. horrida Reuss, plate XI. fig. 14. *Globulina horrida* Reuss, Verst. böhm. Kreide, part 2, 1846, p. 110, plate xliii. fig. 14. *P. horrida* J. Wright, Proc. Belfast Nat. Field Club, App. iii. 1875, p. 85 (87), plate iii. figs. 14, 15.—This characteristic cretaceous foraminifer occurs sparingly in our washings.

Polymorphina sp., plate XI. fig. 15.—One large, irregularly grown form in Mr. Burrows' collection.

UVIGERINA d'Orbigny, 1826.

A fine and perfect specimen of *Uvigerina* was found by Mr. Bailey in Speeton washings, but was unfortunately lost before a drawing had been taken.

RAMULINA Rupert Jones, 1875.

Ramulina aculeata (d'Orb.), plate XI. fig. 16. *Dentalina aculeata* d'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 13, plate i. figs. 2, 3; *R. aculeata,* Wright, Proc. Belfast Nat. Field Club, App. ix. 1886, p. 331, plate xxvii. fig. 11.—Several large isolated chambers of this foraminifer occur in Mr. Burrows' collection. Fragments have also been met with in Mr. Bailey's preparations.

GLOBIGERINA d'Orbigny, 1826.

Globigerina bulloides d'Orb., plate XI. fig. 17. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 277, No. 1.—Frequent in our washings. Jones & Parker record it from Flamborough Head (Emmett Coll.).

G. cretacea d'Orb., plate XI. figs. 18 *a, b, c.* D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 34, plate iii. figs. 12–14.—Very common.

G. Linnæana (d'Orb.), plate XI. fig. 19. *Rosalina Linneiana*

d'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, Foram., p. 101, plate v. figs. 10–12. *G. Linnæana* Brady, Rep. Challenger, ix. 1884, p. 598, plate cxiv. figs. 21*a*, *b*, *c*.—Also common as the last.

ORBULINA d'Orbigny, 1839.

Orbulina universa d'Orb. D'Orbigny, Hist. Nat. Canaries, 1839, Foram., p. 123, plate i. fig. 1.—We have not met with this foraminifer in our washings. It occurs, however, in Mr. Hill's section of red chalk from Bed 1 at Speeton, and also at Great Girendale. It is a rare red chalk form, and is liable to be confounded with the larger of the curious spherical bodies (*incertæ sedis*) which crowd this deposit, the white chalk of Yorkshire, and some of the Norfolk gaults.*

SPHÆROIDINA d'Orbigny, 1826.

Sphæroidina bulloides d'Orb., plate XI. figs. 20, 21. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 267, No. 1. Brady, Rep. Challenger, ix. 1884, p. 620, plate lxxxiv. figs. 1–7.—Occurs twice in Mr. Bailey's slides.

TRUNCATULINA d'Orbigny, 1826.

Truncatulina variabilis d'Orb., plate XI. fig. 22. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 279, No. 8. Brady, Rep. Challenger, ix. 1884, p. 661, plate xciii. fig. 6.—Four chambers of a foraminifer in Mr. Burrows' collection, which we refer with some doubt to this variable Truncatuline.

PLANORBULINA d'Orbigny, 1826.

Planorbulina ammonoides (Reuss), plate XI. figs. 23*a*, *b*. *Rosalina ammonoides* Reuss, Verst. böhm. Kreide, pt. i. 1845, p. 36, plate viii. fig. 53, plate xiii. fig. 66; T. R. Jones, 'Geologist,' vi. 1863, p. 294, plate xv. figs. 7, 8.—Very common in all chalk deposits. Recorded by Jones & Parker from Flamborough Head (Emmett Coll.). The fine specimen figured is from Mr. Burrows' collection.

PULVINULINA Parker & Jones, 1862.

Pulvinulina Menardii (d'Orb.). *Rotalia Menardii* d'Orbigny, Ann. Sci. Nat., vii. 1826, p. 273, No. 26. Brady, Rep. Challenger, ix. 1884, p. 690, plate ciii. figs. 1, 2.—A typical and well-marked specimen of this form was found by Burrows in his Speeton washings, but unfortunately was subsequently lost.

(DISCORBINA Parker & Jones, 1862; vel TRUNCATULINA.)

Discorbina vel *Truncatulina*, plate XI. figs. 24*a*, *b*.—A small rotaline showing affinities to both of these genera. As, however, the

* See this Journal, 1888, p. 383: "I do not think they can be placed with Radiolaria, and they are not to be included with Sponges."—G. J. Hinde, *in litt.* August 25, 1890.

test is much altered by infiltration it would be unwise to attempt to fix its position.

ANOMALINA d'Orbigny, 1826.

Anomalina grosse-rugosa Gümb., plate XI. figs. 25*a*, *b*. *Truncatulina grosserugosa* Gümbel, Abh. k. bay. Ak. Wiss. (cl. ii.) x. (2) 1868, p. 660, plate ii. fig. 104. *A. grosserugosa* Brady, Rep. Challenger, ix. 1884, p. 673, plate xciv. figs. 4, 5. From a fine specimen in the Burrows Collection. We have also noted its occurrence at Hunstanton (Sherborn).

POLYSTOMELLA Lamarck, 1822.

Polystomella macella (F. & M.), plate XI. figs. 26*a*, *b*. *Nautilus macellus* Fichtel & Moll, Test. microsc., 1798, p. 66, plate x. figs. *e–g*, *h–k*. *P. macella* Brady, Rep. Challenger, ix. 1884, p. 737, plate cx. fig. 8.—One small, but perfect individual, Burrows Coll.

In our preliminary list (Journal, 1888, p. 383) we quoted *Lagena aspera* and *L. marginata*, *Nodosaria oligostegia*, *Nonionina* sp., and *Polystomella subnodosa* as occurring in the red chalk. The first of these has turned out to be a piece of matrix, the second was due to false appearance, possibly from an abnormally thick cell-wall; *Nodosaria oligostegia* is absorbed by *N. simplex* Silvestri; *Nonionina* does not occur, nor does *Polystomella subnodosa.*

The whole of the Foraminifera described above, with the exception of *Spiroloculina papyracea*, *Textularia pygmæa*, and *Lingulina carinata*, occur in the red chalk of Speeton. The following lists of occurrences in the red chalk at other localities will be useful to the worker:—

HUNSTANTON, NORFOLK.—*Text. pygmæa*, *T. trochus*, *T. turris*, *Bulim. Presli*, *Lagena brevis*, *L. apiculata*, *Nodos. radiata* var. (*N. limbata*), *Dent. communis*, *Lingul. carinata*, *Crist. rotulata* *C. italica*, *C. crepidula*, *Polymorphina*, *Globig. cretacea*, *G. bulloides*, *G. Linnæana*, *Anom. grosserugosa*, *Planorb. ammonoides*.

CANDLESBY, LINCOLNSHIRE.—Hunstanton limestone, varying from yellowish-pink to true red chalk:—*O. universa*, *G. cretacea*, *G. bulloides*, *L. apiculata*, *Dentalina*, *Verneuilina*, *Miliolina*, *N. radicula* var., *C. rotulata*, *C. crepidula*, *Polymorphina*, *Textularia*, *Glandulina*.

SOUTH CAVE, YORKSHIRE.—Pink limestone:—*O. universa*, *G. cretacea*, *L. apiculata*, *C. crepidula*, *C. variabilis*, *Verneuilina*, *Glandulina*, *Miliolina*. Red chalk (streaky, white and red):—*O. universa*, *G. cretacea*, *G. bulloides*, *Dentalina*, and *Planorbulina*.

FLAMBOROUGH HEAD, YORKSHIRE.—*Spiroloc. papyracea*, *Text. pygmæa*, *Dent. communis*, *C. cultrata*, *C. rotulata*, *C. multiseptata*, *G. bulloides*, *G. Linnæana*, *P. ammonoides*, *Bolivina*, *Polymorphina*, *Lagena*.

Great Girendale, Yorkshire.—*C. crepidula, Polymorphina, G. cretacea, G. bulloides, G. Linnæana, O. universa, Miliolina.*

Whanam Grange, Yorkshire.—*Textularia, Lag. lævis, Pleurostomella* (?), *C. rotulata, C. crepidula, Polymorphina, G. bulloides, G. cretacea.*

The report * appended on Mr. Hill's microscopical sections of red chalks and red gaults shows in an interesting way the connection between the red chalk, red gault clays, and gaults, On the whole, we cannot at present say that the Foraminifera help us in deciding the age of the red chalk, for our knowledge of the fauna of other English cretaceous deposits is very limited. This lack of knowledge will, however, soon be supplied for the gault, at least, as we understand that our friend, Mr. Fred. Chapman, has decided to publish shortly the result of many years' labour on these deposits.

Report on a Collection of Microscopical Sections of Red Chalk and Gault belonging to Mr. W. Hill, F.G.S.

While writing his paper on the Upper Cretaceous Series in Suffolk and Norfolk, in conjunction with Mr. Jukes Brown, Mr. W. Hill prepared a large series of microscopical sections of red chalk, red clays, and gaults. The results of his investigations will be found in the Quart. Journ. Geol. Soc., xliii. 1887, pp. 544 *et seq.*, while below are given some few observations on a selected series of the slides, which he has kindly placed at our disposal. The distribution of the "spheres" is of especial interest.

(1) Hunstanton limestone (yellowish-pink). Top of Rutters Pit, Candlesby, Lincolnshire. A thin section showing little matrix and containing *Orbulina universa, Globigerina cretacea, G. bulloides, Lagena apiculata,* Dentalinæ, Verneuilinæ and Miliolinæ, Ostracoda, spheres and sponge-spicules.

(2) Hunstanton limestone (pink). Middle of Rutters Pit. Little matrix and containing *O. universa, G. cretacea, L. apiculata, Nodosaria radicula, Cristellaria crepidula, C. rotulata,* Dentalinæ, Polymorphinæ, Textulariæ, Miliolinæ, Ostracoda, spheres, and spicules.

(3) Hunstanton limestone (red chalk). Base of Rutters Pit. A thick section, almost entirely composed of Foraminifera and spheres. Contains *G. cretacea, Glandulina,* Textulariæ, Miliolinæ, and others obscured on account of the thickness of the section, Ostracoda, spheres, and spicules.

(4) Streaky red chalk (red and white). From a railway cutting, east of South Cave Station; the organisms occurring in lines and more abundantly in the red than in the lighter coloured streaks.

* C. D. Sherborn is alone responsible for this Report.

Containing *O. universa, G. cretacea, G. bulloides,* Dentalinæ and Planorbulinæ, Ostracoda, spheres, and sponge-spicules in position.

(5) Hunstanton limestone (pink) from South Cave cutting. Almost entirely composed of organisms. Containing *O. universa, G. cretacea, L. apiculata, C. crepidula, C. variabilis,* Verneuilinæ, Glandulinæ, Miliolinæ, Ostracoda, spheres, and sponge-spicules.

(6) Gault from floor of pit at Muzzle, near West Dereham. Full of organisms. *G. cretacea,* Nodosariæ, and others mostly unrecognizable; entire absence of spheres.

(7) Gault, West Dereham, from the base of the gault. Full of organic fragments, but almost entirely devoid of recognizable Foraminifera.

(8) Gault from a well-boring at Stoke Ferry (54–55 feet). Containing *O. universa, G. cretacea, G. bulloides, C. rotulata,* Textularia, and Ostracodal valves.

(9) Red chalk, Whanam Grange, Yorkshire (2 slides), streaky, with abundant Foraminifera, chiefly fragmentary. *G. cretacea, G. bulloides, C. crepidula, C. rotulata, Lagena lævis,* and another, *Pleurostomella* (?), Textulariæ, Polymorphinæ, Glauconitic and brown grains, spheres, sponge-spicules, black specks, with some dendritic markings.

(10) Red chalk, Great Girendale, Yorkshire. Streaky, and although almost entirely composed of spheres and Foraminifera, the latter are not generally recognizable. *O. universa, G. cretacea, G. bulloides, G. Linneana, C. crepidula,* Polymorphina, Miliolinæ, Glauconitic and brown grains, Ostracoda, and spheres.

(11) Red chalk, Speeton, bed 1 (upper part). A thick section showing abundant unrecognizable Foraminifera. *O. universa, G. cretacea, G. bulloides, Cristellaria, Spiroloculina,* and spheres.

(12) Red chalk, Speeton, basal band of bed 1. A thick section almost entirely made up of spheres to the exclusion of other organisms. Containing *G. cretacea, Dentalina, Spiroplecta biformis,* Miliolinæ, spheres, and Ostracoda.

(13) Red chalk, Hunstanton, upper third. Containing *G. cretacea, G. bulloides, N. radicula, C. rotulata, C. crepidula,* Planorbulinæ, Textulariæ, spheres, Ostracoda, and abundant sponge-spicules, some of which are in position.

(14) Red chalk, Hunstanton. Containing *G. cretacea, G. bulloides, L. lævis, N. radicula, C. rotulata,* Planorbulinæ, Polymorphinæ, and other forms of doubtful affinity, spheres, and Ostracoda; few spicules.

(15) Red chalk, Hunstanton (middle). *G. cretacea, G. bulloides, L. apiculata, T. trochus, C. rotulata, C. crepidula, Planorbulina,* spheres, and Ostracoda; few spicules.

(16) Red gault from boring at Hersingham. *G. cretacea, G. bulloides, C. rotulata, Lingulina carinata.* Ostracoda and spicules

are absent, Foraminifera rare, and the spheres characteristic of the red chalk entirely absent.

(17) Gault, Hersingham boring; the brown bed above the red gault. The same as the last, but without *L. carinata.*

(18) Gault, the brook, Grimstone. Densely packed with spheres and Foraminifera; few spicules. *G. cretacea, L. apiculata, Textularia* (very large compared with the other forms), *Miliolina.*

(19) Pink gault, the brook, Grimstone. Similar to the last.

(20) Red gault, Roydon Cutting (Norfolk). Densely packed with spheres and Foraminifera, the latter very small. *G. cretacea, Cristellaria.*

(21) Gault, Roydon cutting. Foraminifera abundant in some layers but absent in others. Spheres entirely wanting. *G. cretacea, Polymorphina* (long var.), *Planorbulina, Textularia, Spiroplecta biformis* (one with ten chambers above the spiral, another with six).

(22) Gault, Roydon cutting (15 feet). A thick section. Foraminifera almost absent. *G. cretacea* only noticed.

(22) Hard nodules from just above the red gault, Roydon cutting. Crowded with spheres. Foraminifera rare (*G. cretacea*).

(23) Gault, lower hard bed, Grimstone Cutting. Containing *G. cretacea*, large *Textularia, Nodosaria, C. rotulata*, spheres and spicules.

(24) "Red chalk, Speeton, No. 3." A thin section, kindly lent to us by Mr. H. Clifton Sorby, F.R.S., showing plenty of matrix. Foraminifera abundant, amongst which can be recognized *G. cretacea, G. Linnæana, Dentalina, Nodosaria, C. crepidula,* Planorbulinæ, Textulariæ, and spheres.

IX.—*Note on a New Type of Foraminifera of the Family Chilostomellidæ.*

By Henry B. Brady, LL.D., F.R.S.

(*Read 15th October*, 1890.)

One of the most curious and interesting features of the Foraminifera, often an element of difficulty to the student, is the tendency of the modifications of the types composing the larger groups to run in parallel isomorphous series. Thus, if the entire Class be divided roughly, as it has sometimes been, into three Orders, comprising respectively the forms characterized by porcellanous, arenaceous, and hyaline tests, species with tests presenting the same general conformation and similar arrangement of chambers may in some cases be found in each of the three series. We have examples of three isomorphous forms—that is to say, of porcellanous, arenaceous, and hyaline genera possessing similar morphological characters—in *Cornuspira*, *Ammodiscus*, and *Spirillina*; in *Alveolina*, *Loftusia*, and *Fusulina*; in *Nubecularia* (*N. tibia* and *N. divaricata*), *Reophax*, and *Nodosaria*; and in $\left.\begin{matrix}\textit{Hauerina}\\ \textit{Peneroplis}\end{matrix}\right\}$, $\left.\begin{matrix}\textit{Trochammina}\\ \textit{Haplophragmium}\end{matrix}\right\}$, and $\left.\begin{matrix}\textit{Cristellaria}\\ \textit{Nonionina}\end{matrix}\right\}$; and a considerable number of instances might be added of two such isomorphous genera. The same tendency exhibits itself even in the smaller groups, most remarkably, perhaps, in the *Rotaliidæ*, of which the species of three or four genera may be arranged in parallel columns, in more or less closely isomorphous series. The phenomenon, in fact, is so common as almost to suggest a general law.

It is somewhat remarkable, however, that hitherto we have been unacquainted with any forms of the hyaline and arenaceous classes corresponding at all closely in general structure to the commonest of all the porcellanous types, those namely of the Sub-family *Miliolininæ*. The characters of the Sub-family are summarized as follows in the scheme of classification appended to the report on the 'Challenger' Foraminifera,*—"Chambers, two in each convolution, coiled on an elongated axis, either symmetrically in a single plane, or inequilaterally. Aperture alternately at either end of the shell"—the entire family, of course, being characterized by the imperforate and (normally) porcellanous and calcareous investment. Turning to the perforate or hyaline series, the only approach to corresponding structure is to be found in the *Chilostomellidæ*. In the genus *Chilostomella* the segments may be said to be two in each convolution, inasmuch as each does not completely inclose that preceding it; they follow each other alternately from the two ends of the test, and the aperture is at

* 'Report on the Foraminifera of the Challenger Expedition,' 1884, p. 61.

the end of the final segment, though not at the extremity of the entire shell.

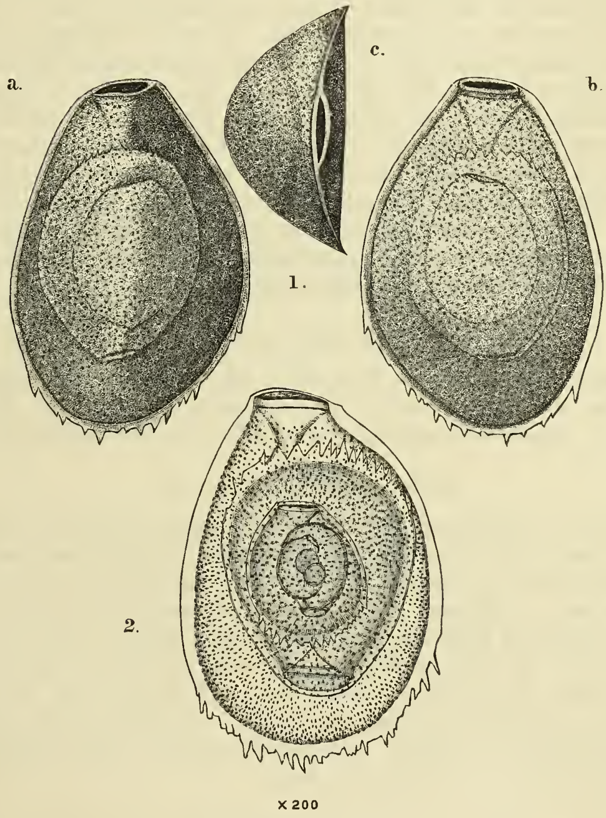
Two years or more ago * my friend Mr. W. H. Harris, then of Cardiff, brought me a mounting with two or three specimens of a Foraminifer, the characters of which did not appear to coincide with those of any hitherto described species. The shells, however, were very minute and their structure obscure, and it appeared better to wait for further material before attempting to work out the points of difficulty they presented. From time to time I have received further specimens from the same correspondent, and I now propose to give as full a description of them as circumstances permit.

Some of the shells referred to are of smaller size than the rest, and whilst possessing the same general features, exhibit certain minute structural differences. Whether the larger and smaller specimens represent different conditions of the same organism or two independent species, the material at my command is insufficient to determine satisfactorily. The present description applies primarily to the larger form, which in any case may be regarded as the type of the genus. The accompanying woodcuts, from very careful drawings by Mr. Hollick, give an accurate idea of the general features of two of the larger shells. The largest example I have seen is scarcely 1/100 in. (0·25 mm.) in length, and somewhat resembles a compressed *Biloculina*, though of less symmetrical configuration. The outline is approximately oval, more or less inequilateral, broader towards the aboral end, tapering a little towards the oral extremity; one face of the shell is convex, the other nearly flat, and the peripheral edge sharp and subcarinate. The margin of the broad aboral end is serrate, the teeth being irregular as to size and disposition. The smaller specimens, above referred to, have even margins, without carina or serration. The aperture is simple, and consists of a long narrow opening, surrounded by a thickened lip, occupying the superior extremity of the test. The shell-wall is exceedingly thin and transparent, and distinctly porous, the perforations being minute and evenly distributed. Owing to the small size and extreme fragility of the shell, it is almost impossible to study its internal structure by means of sections; nor is this needful, inasmuch as the condition of the interior is readily made out from specimens mounted in Canada balsam, and viewed by transmitted light. From a shell so mounted (fig. 2) it may be seen that the adult organism consists of about seven segments; that the primordial chamber is round, and that it is followed by another of similar size and shape; that these are partially embraced by a long, arched, Milioline chamber with terminal aperture, and that this again is succeeded by one of like contour on the opposite side, with the aperture at the opposite end. The three remaining chambers each completely envelopes those

* In June 1888.

previously formed, or at any rate appears to do so when viewed in this way. They are not, however, equilaterally disposed, but lie in the hollow of the convex side of the inclosing chamber, to which they are adherent, closely resembling *Chilostomella* in this respect. Whether the wall in this region is double, or the final segment leaves a portion

Fig. 60.



Seabrookia pellucida.

Fig. 1, *a*, *b*. Lateral aspects. *c*. Oral aspect.
Fig. 2. Specimen mounted in Canada balsam and viewed as a transparent object.
(All magnified 200 diameters.)

of the wall of the penultimate exposed (as in *Biloculina*), I have not been able to make out satisfactorily. The outline of the penultimate segment, and sometimes that of the ante-penultimate, can be easily traced on the exterior, but this may be entirely due to the tenuity and transparency of the walls; at the same time it is possible that

this portion may be the wall of the inner chamber partially exposed. The size of the smaller specimens to which reference has been made is rather more than 1/200 in. (0·127 mm.) in length, that of the larger somewhat less than 1/100 in. (0·25 mm.), the breadth being about two-thirds the length. The largest, and on the whole the best, examples hitherto found, were obtained by Mr. Harris from sand dredged in the Java Sea, by Captain Seabrook, the master of a merchantman, unfortunately lost in the Samoa hurricane two years ago. Smaller examples occurred in a dredging made off Cebu, Philippine Islands, and more recently the same form has been met with in 'Challenger' material from Station 33—off Bermudas, 435 fathoms. As stated at the commencement, I am indebted to Mr. W. H. Harris for the specimens which form the subject of the present Note, and it seemed fitting that the organism should bear his name, but he prefers that it should be associated with that of Captain Seabrook, and I have acted accordingly. Further research with a larger supply of material will probably add to our knowledge of the type, meanwhile the following provisional descriptions will serve for its identification.

Seabrookia, nov. gen.

Essential characters:—Test free, hyaline, perforate; composed of a number of chambers, each inclosing, partially or entirely, that preceding it; aperture terminal, alternately at the two ends of the test.

Seabrookia pellucida, n. sp.

Test oval, depressed, the two sides unequally convex, sometimes almost plano-convex; aboral end broad and rounded, oral end somewhat drawn out; peripheral edge acute or subcarinate, in large specimens serrate. Composed of a number of segments, the later chambers of the adult shell each inclosing, partially or entirely, those preceding it, a portion of the penultimate segment visible externally on the gibbous face of the test. Walls thin and transparent, smooth, or nearly so, externally, minutely perforated. Aperture simple, terminal, taking the form of a linear or elongate-oval slit with thickened lip. Length 1/100 in. (0·25 mm.) or less.

The facts which have been brought forward are sufficient to show that we have in *Seabrookia* a tolerably close isomorph of *Biloculina*, the one belonging to the vitreous series of Foraminifera, the other to the porcellanous. Further, that amongst already known types its nearest ally is *Chilostomella*, and that its natural position is in the *Chilostomellidæ*, probably between *Chilostomella* and *Ellipsoidina*.

Postscript.—Since the foregoing Note has been in the printer's hands and the woodcuts prepared, I have learnt, quite accidentally, that the smaller form above referred to is the organism of which a MS. name without description (*Millettia earlandi*) appeared in my friend Mr. Joseph Wright's list of Foraminifera dredged in 1000 fathoms off the south-west coast of Ireland, on the 'Flying Fox' expedition; published in the 'Annals and Magazine of Natural History' for December 1889: and that a detailed description both of this and the larger form has been prepared by him for the Report of the dredging expedition on the same or adjacent ground in the steam-tug 'Flying Falcon,' 1888, which has been already presented to the Royal Irish Academy, though not yet published. Mr. Wright, nevertheless, has very kindly expressed his wish that this notice should not be withdrawn, and as it is admitted that Mr. Harris was the first to find the organism and recognize in it an undescribed type, it is fair that his position with regard to it should be respected. I only regret that my prolonged absence from England through ill-health should have been the cause of any question of priority in the matter.—H. B. B.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

α. Embryology.†

Inconsistencies of Utilitarianism as the Exclusive Theory of Organic Evolution.‡—The Rev. J. T. Gulick thinks he finds various inconsistencies in the exclusive use of utilitarianism as explanatory of the theory of evolution, and expresses his conviction that his theory of divergence through segregation can consistently explain them.

Embryology of Vertebrates.§—M. F. Houssay has made a series of studies of the development of the Axolotl. He finds that as the ovum of Batrachians has a shell it incloses dense nutrient materials; the egg is very large, and as a result, its segmentation is unequal. The poles are not previously determined. There is no epiboly; in other words, the epiblast does not arise from four initial superior cells, but from all the peripheral cells. The pigment and size of the granules cannot be considered as characteristic of the elements. There is no "hypoblast of invagination"; that is to say, the dorsal wall of the intestine does not come from without, but is organized on the spot; the multiplication of the cells of this wall and their precocious differentiation are the result of the diminution of pressure caused by the increase in the dorsal epiblast which is preparing to give rise to the nervous system. As the

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Amer. Journ. Sci., xl. (1890) pp. 1–14. Ann. and Mag. Nat. Hist., vi. (1890) pp. 125–39.

§ Arch. de Zool. Expér et Gén., viii. (1890) pp. 143–244 (5 pls.).

same cause does not exist on the ventral or lateral surfaces there cannot be the same result; hence the difference between the dorsal and ventral walls of the intestine. The multiplication of the elements of the dorsal wall of the intestine causes the formation of a layer which grows in and leaves below it a space—the intestine—while it becomes, dorsally, attached to the two other layers. The curvature of the dorsal wall of the intestine causes the curvature of the blastopore which becomes at first semilunar and then circular. The blastopore persists and forms the permanent anus.

The author next deals with the origin and development of the peripheral nervous system. He confirms the results of Beard as to the epiblastic derivation of the dorsal roots of the cranial nerves. He describes the primitive stage of the cranial ganglia as an unsegmented epiblastic band which, later on, extends into the trunk to form the lateral nerve and line. While this cord is being differentiated posteriorly it becomes segmented anteriorly to give rise to the different ganglia, and this segmentation follows that of other parts of the head. The central nervous system, which is at first unsegmented, is directly metameric in the brain and spinal cord; this metamerism, which is easily recognizable in young examples, is called "neurotomy." The dorsal spinal and the cranial roots of the nerves arise behind the neurotome of their segment, and their relations with it are secondary. The ciliary and the auditory nerves have each a postbranchial branch, which passes behind the branchial cleft of their segments. The facial nerve not only has a suprabranchial branch which is double at its extremity, but the ganglion itself is double and has two postbranchial branches, one of which passes behind the hyo-mandibular cleft and the other behind the hyoidean. The author believes that he has removed any difficulty with regard to the identity of the segments of the trunk and of the head, and he believes that he has established the complete homodynamy, at least in its fundamental parts, of the peripheral nervous system of all the metameres of the body.

In his third essay M. Houssay treats of the metamerism of the head, and discusses the principles on which the determination of the metameres must be based. The segments appear at different points and at different times and obey no simple law. There is an absolute agreement in the way in which the central nervous system (neurotomy), the peripheral nervous system (neuromery), the branchial intestine (branchiomery), and the mesoderm (mesodermery) become divided. At the same time it is to be noted that parts which typically ought to exist, retrograde or are even not produced at all, and thence arise errors in the theories as to the segments of the head.

In addition to the cephalic segments which are generally admitted—the nasal, the mandibular, the hyoidean, and the branchial, the author brings forward evidence in favour of the oculo-hypophysial, of which he finds the branchial cleft, the postbranchial nerve, and the mesodermal segment; of the buccal; of the hyo-mandibular, of which he fixes the branchial cleft, the ganglion, and the post-branchial branch; and of the auditory.

Further arguments are required to justify us in regarding the oculomotor, the trochlear, and the abducens nerves as ventral roots.

Placenta of Dugong.*—Prof. Sir W. Turner has been able to show that the placenta of *Halicore Dugong* is not, as Harting supposed, diffused, but is truly zonary; at the same time it is certain that it is in whole or in great part non-deciduate, so that we now know of two types of zonary placenta, the deciduate, found in Carnivora, Pinnipedia, *Elephas*, and *Hyrax*, and non-deciduate in the Dugong, and probably also in the Manatee.

Development and Life-histories of Teleostean Food- and other Fishes.†—Prof. W. C. M'Intosh and Mr. E. E. Prince have published the results of several years' labours at St. Andrews Laboratory. They endeavoured to examine as thoroughly as possible the ovarian growth, oviposition, hatching, and development of such of the important white fishes as could be obtained, and to fill up the gaps in our knowledge of the period between the escape of the embryo from the egg and the young, though advanced, forms known to naturalists and fishermen. The ova of about forty British fishes have been examined; some of them were pelagic or floating as of the Turbot, Plaice, Flounder, Sole, Whiting, and Sprat, and others non-pelagic or demersal as of the Herring, Smelt, Salmon, Stickleback, and Sea-Bream.

The mature ovum is first treated of, and there are remarks on the reproductive organs and period of spawning; extrusion and deposition, segmentation, the blastoderm, the periblast, the embryonic shield, the general development of the trunk, the fins, the embryonic, larval, and post-larval stages, general remarks, and a history of *Anarrhichas lupus* form the subjects of successive chapters. The reader must be referred to the memoir itself for the numerous details which it contains.

β. Histology.‡

Nuclear Modifications which affect the Nucleolus.§ — M. E. Bataillon describes some early stages in the histolysis of Amphibians, which may be well studied in the cutaneous elements of the tail, though they are to be seen in other tissues also. Elongated elements may be found, of which the upper extremity is swollen like a club and contains the nucleus; starting from it is a thread which becomes intensely stained by nuclear reagents, passes into the handle of the club, and extends more or less towards the base. The following stages of the phenomenon may be observed:—The nucleolus becomes pushed to the periphery of the nucleus, and appears to protrude a process about double its own diameter; above the nucleus is a kind of rod which half surrounds it, and still arises from an internal nucleolus; the most varied free forms surround the nucleus and end in a swelling. The author thinks that the normal chromatic filament may be developed at the expense of the plasma of the nucleolus by absorbing grains of chromatin, while the nucleolar filament may be formed by a condensation of the hyalo-plasmic framework, of which the nucleolus is in some

* Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 641–62 (3 pls.).
† T. c., pp. 665–946 (28 pls.).
‡ This section is limited to papers relating to Cells and Fibres.
§ Comptes Rendus, cx. (1890) pp. 1217–9.

way the centre. In either case the nucleolus is seen to be an element of the highest importance in the biology of the cell.

Division of Pigment-cells and Capillary Wall-cells.*—Prof. W. Flemming gives an account of some observations which, like the budding of Protista and the division of leucocytes, show that a cell-body may be divided by forces which need not in any way correspond with those which are active in the division of the nucleus.

B. INVERTEBRATA.

Functions of Central Nervous System of Invertebrates.†—Prof. J. Steiner has a short account of his experiments on the central nervous system of various Invertebrates. He comes to the conclusion that, while the Arthropoda have a true brain like that of Vertebrates and represented by the dorsal œsophageal ganglion, no others of the Invertebrates have a brain. In the Mollusca and Annelida this dorsal ganglion is, according to our present knowledge, only a sensory centre; in the unsegmented worms (of which *Distoma hepaticum* is taken as the type) the dorsal ganglion forms the whole of the central nervous system; on the one hand, it is the primary centre of the locomotor organs, but at the same time it is also a sensory centre. Further investigations must show whether other distinct types of nervous systems are exhibited by the Echinodermata and Cœlenterata.

Animal Parasites of Sheep.‡—Dr. Cooper Curtice has published a report on the parasites of the sheep, which ought to be of particular interest and value. Twenty-six species of animal parasites are recorded, six of which are Cestodes, three Trematodes, and ten Nematodes, the rest being Arthropods of various groups; nine of all these are the most destructive. A new species is described in the form of the nematode *Œsophagostoma columbianum*, which seems to be the cause of a hitherto undescribed disease which is characterized by tumours in the upper part of the large intestine; one great misfortune of this disease is the disturbance to the business of the sausage-makers, who are compelled to import the greater part of the covering material which is used in their business. The origin of this pest, which does not seem to have been brought over to America from the Old World, is still obscure, and the complete life-history of the species has still to be made out.

German Names for Porifera, Cœlenterata, Echinoderms, and Worms.§—As English-speaking naturalists are very often at a loss to know what is meant by the German name of an animal or a group—e.g. by Kieferwürmer and Röhrenkieferwürmer, or by Würzelschopfschwämme, we may call attention to a useful list lately published by Dr. E. v. Marenzeller.

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 275–86 (1 pl.).
† SB. K. Preuss. Akad. Wiss., 1890, pp. 39–49.
‡ 'The Animal Parasites of Sheep.' U.S. Department of Agriculture, Washington, 1890, 8vo, 222 pp. and 36 pls.
§ Abh. Zool.-Bot. Gesell., xl. (1890) pp. 177–84.

Mollusca.

Revision of British Mollusca.*—Canon Norman continues his revision, and now deals with the Gastropoda; dealing first with the Pteropoda he enumerates six species. The Opisthobranchiata and the Nudibranchiata are next enumerated, one hundred and fifty-three species being recognized.

Sensory Organs of Lateral Line and Nervous System of Mollusca.†—Dr. B. Rawitz calls attention to certain points in Herr Thiele's memoir,‡ in which he thinks he has been misrepresented; and promises to show that some of that author's results are not in correspondence with the facts of the case.

α. Cephalopoda.

Genesis of the Arietidæ.§—Mr. A. S. Hyatt's prolonged researches on the Arietidæ, now published in a large monograph, include an account of the genealogy of the three great stocks—*Psiloceras*, *Plicatus*, and *Levis*, and their subordinate series; of the genesis of characteristics —progressive, retrogressive, and differential; of the geological and faunal relations; and of the genera and species. The author's theoretical conclusions are tersely summed up in a preface, and expounded in an introductory chapter, but a complete summary would involve an explanation of terms exceeding the limits of our space.

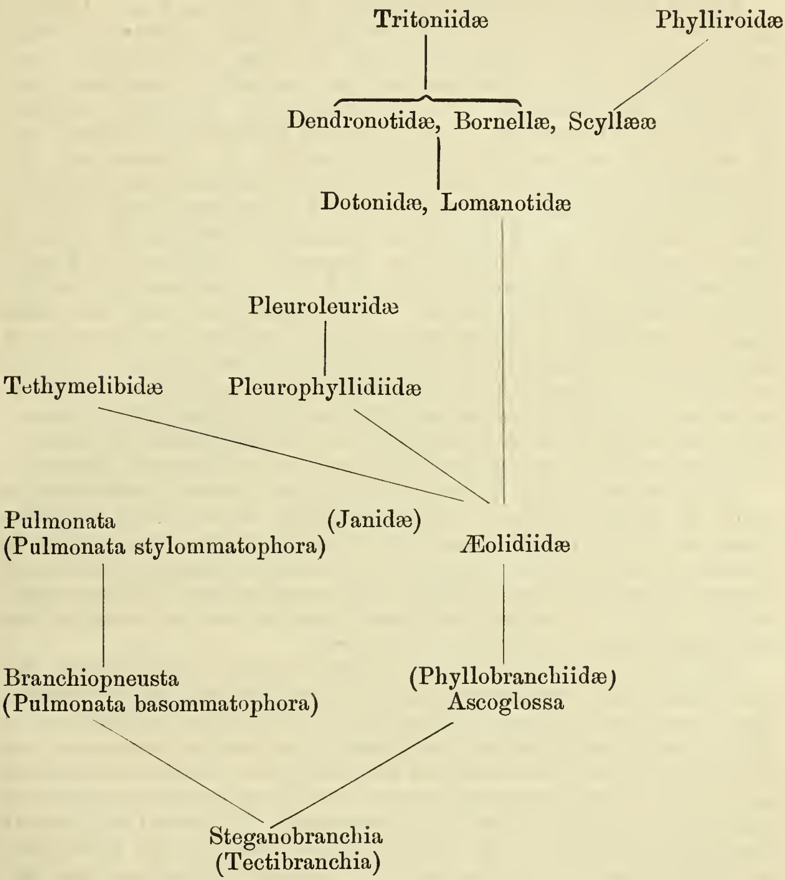
"Specialization has in all cases appeared to us to be due, *not to natural selection, but to physical selection*, or the production of suitable modifications by the action of forces which changed in a similar way large numbers of the same species, perhaps nearly all the individuals in the same locality or same habitat, within a comparatively limited period of time." "We do not intend to dispute entirely the action of natural selection and the influence of the struggle for existence, but simply to deny the applicability of the law to the more important modifications and series of modifications which have occurred in the history of animals, taking the fossil Cephalopods as a type." "Changes in the surroundings acted upon the plastic organism, inducing it to make efforts to accommodate itself to new conditions." "In so far as causes and habits are similar, they probably produce representation or morphological equivalence between different series or forms of the same type in the same habitat, and in so far as they are different, they probably produce the differentials which distinguish series and groups from each other."

γ. Gastropoda.

Cladohepatic Nudibranchs.‖—Prof. R. Bergh emphasizes the contrast between the Steganobranchiata (Tectibranchiata) and the Nudibranchs, but finds connecting links in the order Ascoglossa. The latter are allied especially to the cladohepatic Nudibranchs, the holohepatic

* Ann. and Mag. Nat. Hist., vi. (1890) pp. 60–91.
† Zool. Anzeig., xiii. (1890) pp. 361–4. ‡ See this Journal, *ante*, p. 160.
§ Smithsonian Contributions, xxvi. (1890) 238 pp., 14 pls. and 35 figs.
‖ Zool. Jahrb., v. (1890) pp. 1–75.

forms being more remote. The scheme of relationship which Bergh supports is as follows:—



The memoir gives diagnoses of the various families of cladohepatic Nudibranchs noted in the above scheme from the Æolidiidæ which are nearest to the Ascoglossa, to the Tritoniidæ, which approach most closely to the holohepatic forms.

The Titiscaniæ.*—Dr. R. Bergh establishes the new genus *Titiscania*, and makes it the type of a family of Rhipidoglossal Prosobranchiates. The animals are shell-less and slug-like; in internal structure, e.g. gills and lingual armature, they belong distinctly to the group Neritaceæ; while the structure of the radula and the absence of the median plates suggest a position in the subdivision Neritopsidæ. Bergh gives a detailed account of *Titiscania limacina* sp. n. from one

* Morphol. Jahrb., xvi. (1890) pp. 1–26 (3 pls.).

of the Philippines and Mauritius, and adds for purposes of comparison a description of *Nerita peloronta* and *Neritella pulligera*.

Pallial Organs of Prosobranchiata.*—M. F. Bernard has a lengthy memoir on the pallial organs of the Prosobranchiata. After some introductory chapters he discusses in detail the organ of Spengel; first in *Cassidaria*, where differentiation has reached a maximum; the progressive differentiation in the Diotocardia is traced through the Neritidæ, Fissurellidæ, Trochidæ, and Haliotidæ; similarly the Monotocardia are described—the Valvatidæ, the Littorinidæ, the Vermetidæ, and others, the Naticidæ, the Siphonostomata proboscidifera, the Rachiglossata, the Cypræidæ, and the Toxoglossata, being taken in order; next *Helicina* and *Cyclophora*, Prosobranchs without the organ of Spengel, and then the Patellidæ are discussed. The organ of Lacaze Duthiers in the Pulmonata, Paludina, and the Opisthobranchs are the subjects of the next three chapters. The author, in his third part, deals with the structure of the branchial lamellæ, making a special study of the muscular elements and the interepithelial nervous plexus. Finally, with the mucous gland a study is made of secreting elements. Morphological and histological comparisons of the neuroepithelial cells in Gastropods and Acephala, the morphology of the venous system, the connective tissue and blood-spaces form the subject of more general chapters.

We have only space to deal with the more general conclusions at which M. Bernard arrives. Nothwithstanding the numerous variations presented by the pallial organs in the different types examined, it is possible to show that not only are the homologous organs composed of the same elements, however different their morphological differentiation, but also that, in a general way, these elements always belong to the same types, whatever organs are considered.

Thus, there are three types of epithelial cells—the secretory, the indifferent (which is generally ciliated in Prosobranchs), and the sensory. The connective elements are of four kinds—multipolar, plasmatic, endothelial, and greatly elongated cell-fibres. The nervous elements do not differ from the two forms described for other organs—these are multipolar ganglion cells with prolongations, some of which are much more important than others, and nerve-fibres with proper nuclei. This result is of special interest, as it applies to the nervous plexuses found in the epithelium, and hitherto incompletely known. The muscular elements are very frequently branched; they form long narrow bands or short trabeculæ with numerous prolongations, which connect two adjoining connective plates.

All these elements are, as a rule, found in all parts of the mantle, and in all the pallial organs, whatever be their degree of differentiation. The cause of the differentiation of an organ or its functional specialization is the accumulation of certain elements of each of these categories.

For example, the three varieties of epithelial cells exist normally in the mantle, but in the region between the rectum and the gill the glandular cells are much more abundant than elsewhere, and the region becomes specially secretory. A simple modification of the epithelium brings about this transformation. The accumulation of glandular elements is correlated with the formation of folds which increase the

* Ann. Sci. Nat., ix. (1890) pp. 89-304 (10 pls.).

secreting surface, and the gland becomes localized, while it is more sharply marked off in higher types. The gill, as has long been known, is only a continuation of the folds formed by the internal layer of the mantle; in the interior of these folds there is a system of muscular fibres which may adduct or abduct the two folds, and so diminish or increase the blood-spaces. When differentiation is highest the different regions of a lamella are, in consequence of the localization of the different epithelial elements, either secretory (on the afferent edge), sensory (on the efferent edge), or merely respiratory. The organ of Spengel is clearly sensory in function; it owes its form to the accumulation of neuro-epithelial cells on a nerve which either arises from (Diotocardia) or ends in (Neritidæ, *Valvata*) the branchial ganglion, and persists after the ganglion disappears.

These elements are not different from those which are found in other pallial organs, and that of Spengel has only a general sensibility; when the differentiation is greatest the large number of nervous and neuro-epithelial cells which are present, the appearance of pigment-cells, and the localization of the groups of elements, show that sensibility has increased, but do not demonstrate whether the sensibility is tactile or olfactory.

Compared with the results obtained as to the tissues of the Pulmonata, Opisthobranchiata, and Acephala, we may note certain points of remarkable agreement; at the same time dermal gland-cells are wanting from the mantle of Prosobranchs, although present in the foot.

With regard to the classification of the group, M. Bernard urges that the distinction between bipectinate and monopectinate gills is of capital importance, because it clearly agrees with the principal characteristics drawn from other organs, and particularly those recently investigated by M. Bouvier and M. R. Perrier. In other words, the groups Aspidobranchiata and Pectinibranchiata agree with the Diotocardia and the Monotocardia; *Valvata* has a bipectinate gill, while most of its characters approximate it to the Tænioglossata. In the Patellidæ, the gill of *Tectura*, like its nervous system, inclines us to place it with the Diotocardia, but the heart and kidney would make us separate it from them.

Among the Diotocardia, the classification, proposed by Spengel and adopted by Bouvier, into Zygobranchiata and Azygobranchiata does not appear to be satisfactory. The most natural classification seems to agree with that of R. Perrier, and in it we have the following divisions:—

A. Scutibranchiata = Diotocardia = Aspidobranchiata = Rhipidoglossata.
   (1) Fissurellidæ (Homonephridiata).
   (2) Trochidæ, Turbonidæ, Haliotidæ, &c. (Heteronephridiata).
   (3) Neritidæ (Mononephridiata = Orthoneuroidea).
B. Cyclobranchiata = Heterocardia = Doxoglossa.
   Patellidæ, Tecturidæ, Lepetidæ.

In the Monotocardia the false gill varies considerably, and its different degrees of complication have been utilized by M. Bouvier in his classification; they agree with the characters drawn from the anterior part of the digestive tube and the nervous system. The author consequently proposes no change in the classification proposed by his predecessor.

Gland of Auricle in Paludina, and Nephridial Gland in Murex.*—M. L. Cuénot describes the wall of the auricle of *Paludina vivipara* as being considerably thickened. It is covered externally by a cubical epithelium, below which is a thick muscular and connective zone, which is crowded with nuclei; on its inner side this zone is in direct contact with the blood. On teasing the wall, after treatment with osmic acid, picro-carmine and glycerin, the nuclei of the stroma may be seen in the course of being transformed into amœbocytes. A considerable number of them are surrounded by the refractive granules characteristic of mature amœbocytes, and are ready to pass into the cavity of the auricle; it is quite obvious that we have to do here with a lymphatic gland. Fixation with Flemming's liquid shows the same facts even more distinctly. The author has already described another lymphatic gland in *P. vivipara*, which is situated in the gills. The products of these two glands are identical, and the two organs are simultaneously functional.

The nephridial gland of *Murex brandaris*, teased as before, is found to have its glandular tissue formed of a plexus of fibres, crowded with nuclei and cells. The former do not develope into amœbocytes, but take, on their death, the place of certain cells. These cells, of which there is a large number, are very large (10 μ to 25 μ), ovoid or spherical in form, and are bounded by a very distinct fine membrane. They inclose a central nucleus; the cellular cavity is filled with large refractive granules, which are yellowish-green during life and proteid in composition. When alive they actively absorb fuchsin, and become red; they are coloured grey by osmic acid. These cells are not a characteristic element of the nephridial gland, for they are found wherever there is connective tissue, but they are specially abundant in that organ. The histological structure of the nephridial gland of *Murex brandaris* leads us to suppose that it is not a lymphatic organ, but merely an organ of reserve.

Mechanism of Respiration in Ampullariidæ.†—MM. P. Fischer and E. L. Bouvier have had the opportunity of studying the mechanism of respiration in *Ampullaria insularum* and *Lanistes Bolteniana*. The former of these was the subject of the observations of Guilding, Cazenavetti, and Bavay, and, when in water, exhibits a mode of pulmonary respiration curiously similar to that of Cetacea. When immersed in water the mollusc breathes by its gills. As the siphon divides the left pallial cleft into two slightly unequal halves fine granules of carmine may be seen to penetrate into the chamber by the right half of the cleft; they are rapidly directed from before backwards, and from right to left, and the water does not seem to take more than six to eight seconds to make the entire course of the branchial chamber. When the animal is on land the lung plays an essential and exclusive part in respiration; the pulmonary orifice opens and closes alternately, but not with great regularity, and these movements correspond to elevations and depressions of the floor of the lung. These irregular movements of inspiration and expiration are powerfully aided by the general movements of the body.

While *Ampullaria* is dextral, *Lanistes* is sinistral, and the mechanism of respiration is altogether different. *Lanistes* respires air and water by the

* Comptes Rendus, cx. (1890) pp. 1275–7. † T. c., cxi. (1890) pp. 200–3.

siphon, and does not move its head in the way which is so characteristic of the aerial respiration of *Ampullaria*. The animal comes to the surface, extends its siphon into the air, and so renews the air in the lung. *Lanistes* seems to be much less aerial in its respiration than *Ampullaria*, for it comes much less rarely to the surface. The elongation of the siphon in *Ampullaria* and the physiological differentiation between the siphon and pallial cleft is to be explained as due to its better adaptation to aerial life. The mode of aquatic respiration in *Lanistes* is very similar to that of *Ampullaria*.

Olfactory Sense of Snails.*—M. R. Dubois has made a number of experiments on the sense of smell in *Helix pomatia*. He concludes that (1) the larger tentacles are more sensitive than any other points of the integument; (2) the sensibility of the smaller tentacles to various olfactory stimuli, although very general, is much less marked than that of the larger; (3) the olfactory sensitiveness of the rest of the integument is only evident for very few stimuli (such as vapour of benzine), and even for these stimuli it is much less marked than that of the tentacles; (4) in the large tentacles sensibility is not confined to the extremities, though it is more marked there than elsewhere. The author's experiments lead him to think that, for the special senses, primary excitation is mechanical, as it is with the tactile organs strictly so called.

New Neomeniæ from the Mediterranean.†—M. G. Pruvot has found at Banyuls eight species of *Neomeniæ*, all of which, with the exception of *Proneomenia aglaopheniæ* and *P. desiderata*, are new. Three of the species belong to the genus, lately established by Hubrecht, *Dondersia;* these are called *D. banyulensis*, *D. flavens*, and *D. ichthyodes;* the last would deserve separate generic rank did a sufficient number of specimens afford material for a comparative study. *Paramenia* is a new genus which exhibits a remarkable mixture of the characters of *Neomenia* and *Proneomenia;* three species—*P. impexa*, *P. sierra*, and *P. palifera* – are placed in it; the last of these was, unfortunately, represented by a single individual, for the form and distribution of its spicules, the absence of penial spicules, and the reduction of the radula afford characters which indicate the generic distinctness of the species. Further details are promised.

Circulatory Apparatus and Gonads of Neomeniæ.‡—M. G. Pruvot states that the so-called heart of the Neomeniæ is very variable in its constitution, even within the limits of a single species. In some cases it appears to be a simple fold of the dorsal wall of the pericardium, while in others it is entirely detached in its median part. It never has any muscular elements, but is formed of a mass of connective cells which are sometimes arranged compactly and sometimes leave between them spaces, in which blood-cells accumulate. It is not connected with a dorsal vessel—which does not exist—but with a dorsal sinus. The heart also varies considerably in form; in *Dondersia flavens* and *D. banyulensis* it is cylindrical; in *Proneomenia aglaopheniæ* and *P. desiderata* it is flattened and slightly bilobed, while in *P. sierra* it has the form of a

* Comptes Rendus, cxi (1890) pp. 66–8.
† Arch. Zool. Expér. et Gén., viii. (1890) pp. xxi.–iv.
‡ Comptes Rendus, cxi. (1890) pp. 59–62.

plate flattened dorsoventrally and divided by a constriction into an upper and a lower mass.

The gonads are two long tubes with proper and continuous walls; in their lower part they gradually acquire a common envelope which is at first connective and then muscular, and which also incloses the dorsal sinus. They, like the pericardium, have no relation with the general cavity, and like it, do not contain a single blood-cell. The pericardium is lined by a pavement epithelium, which is continuous and forms on the sides two longitudinal folds, where the cells become higher, cubical and ciliated.

The author concludes that the so-called heart is not a propelling organ, as it is often devoid of a cavity, and never has contractile elements; morphologically it is a mere dorsal raphe, a continuation of the septum of the gonad which becomes incomplete and incloses a portion of the general cavity; physiologically, it aids in forming, on each side, with the lateral ciliated folds of the pericardium, a groove such as that which is seen at the end of the gonad of hermaphrodite Gastropods, and it is destined, like it, to separate the male and female elements which have hitherto been mingled with one another. The spermatozoa are conveyed into a special portion of the nephridial tubes, or into two long seminal vesicles, while the ova pass from the groove and accumulate in the so-called pericardium; this last is nothing more than an accessory pouch of the genital apparatus.

The so-called nephridial tubes are simple genital ducts which have neither renal function, since their epithelium is not glandular, nor the value of segmental organs, since they do not communicate with the general body-cavity; in fact, the genital apparatus, as a whole, recalls most nearly that of hermaphrodite Gastropods, with the difference that, in the Neomeniæ, all the parts are paired and symmetrical.

δ. Lamellibranchiata.

Identity of Composition of Nervous System of Lamellibranchiata and other Molluscs.*—M. P. Pelseneer points out that in most Mollusca each pedal ganglion receives two connectives—the more ventral or more anterior, which comes from the cerebral ganglion, and the more dorsal or posterior, which arises from the pleural ganglion. This arrangement is general in Gastropods, and has been found also in Cephalopods and in *Dentalium*. The absence, in Lamellibranchs, of the pleuro-pedal connective and of a distinct pleural ganglion have been regarded as definitely characteristic of the class; however, in *Nucula* and *Solenomya*, more primitive genera which M. Pelseneer has united under the group-name Protobranchiata, the pleural centres and the pleuro-pedal connectives are to be found. In *Nucula* the cerebral ganglia occupy the usual position, above the œsophagus; they each give off fibres which pass to the adductor muscle and to the palps, as well as the connective which unites the cerebral centre to the corresponding pedal ganglion. More posteriorly, at the point where, as a rule, the visceral commissure commences, there is a ganglion which is as large as the cerebral; this gives off the visceral commissure posteriorly and the anterior pallial

* Comptes Rendus, cxi. (1890) pp. 245-6.

nerve externally, while, ventrally, there is a strong nerve-cord which is directed towards the pedal ganglion, which, about half-way on its course, becomes united with the cerebro-pedal connective.

In *Solenomya* there is a similar arrangement, with the sole difference that the nerve-fibres which go from the ganglion at the origin of the visceral commissure as far as the pedal centre join those of the cerebro-pedal connective on their exit from the ganglion; in this way the common trunk which they form arises from the junction of the cerebral ganglion with that which is connected with it posteriorly.

If we compare the arrangement observed in *Nucula* and *Solenomya* with that which obtains in Gastropods and *Dentalium*, we see that the ganglion from which arise the anterior pallial nerve, the visceral commissure, and the fibres which pass to the pedal centre, is the pleural ganglion, while the fibres which join this last centre to the pedal ganglion of *Nucula* and *Solenomya* form the pleuro-pedal connective which was believed to be wanting in the Lamellibranchiata. In such as are more specialized than these two Protobranchs the pleural and cerebral ganglia are fused into a single ganglionic mass (which is always called the cerebral), as may be seen when sections of the mass are made, and the two connectives—the cerebro-pedal and pleuro-pedal—are united for their whole length.

Progression and Rotation of Bivalve Molluscs and of Detached Ciliated Portions.*—Mr. D. M'Alpine has continued † his observations and experiments on this subject, and now gives an account of what he has observed in the freshwater mussel (*Unio*), in which the general results are much the same as with *Mytilus*, and in the Oyster.

When the movements of these three forms are compared in their natural condition, it will be found that *Unio* has the greatest activity, and *Ostrea*, as far as known, the least; but if the progressive and rotatory movements due to cilia are in question, then *Mytilus* undoubtedly takes the lead. Each of these three forms has a distinct and specially active part, suggestive of underlying differences; in *Mytilus* it is the gill, in *Unio* the ventral margin of the foot, and in *Ostrea* the labial palp. The cilia are supposed to continue their work without any rest, but it may be imagined, in a structure like the gill, with its innumerable cilia, that they rest in relays without interfering much, if at all, with the general effect.

In the course of his investigations the author noticed an important distinction between the action of the cilia and the movement of the cilia-bearing mass. The movement of the mass might cease and yet the cilia themselves, when examined under the Microscope, would be in active motion. The cilia in themselves are, therefore, not the cause of movement; there has to be co-operation or co-ordination of some sort before the ciliary motion can give rise to movement of the part bearing the cilia. Ciliary motion which causes currents in streams must, therefore, be distinguished from ciliary motive power.

Organ of Bojanus in Anodonta cygnea.‡—Dr. W. M. Rankin gives a very full account of his observations on the organ of Bojanus in the

* Proc. Roy. Soc. Edinb., xvi. (1888–9) pp. 725–43 (2 pls.).
† See this Journal, 1889, p. 739.
‡ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 227–67 (2 pls.).

Mussel. He divides his account of its macroscopic anatomy under the heads of (1) renal duct and ureter, (2) renal sac, (3) tip of organ, (4) its loops, and then deals with its blood and nerve supply. Its microscopical characters are first treated of in relation to the structure of the walls, the epithelial cells, and the sensory epithelium being next dealt with. The walls of the organ are found to be composed of a homogeneous ground-substance with which are associated various kinds of connective-tissue-cells. These form a delicate wall for the true kidney and a firmer partition between it and the pericardium. Smooth muscle-cells are scattered between the connective cells. The apices or tips are formed of firm bandlike connective and muscular cells which are arranged circularly and longitudinally. Around the ureters the fibres are chiefly arranged in a circular manner.

The epithelial investment consists of three kinds of cells; the excretory with scattered flagelliform cilia, which are found in the whole of the organ except the tips and ureters; in these last there are cylindrical cells with closely set cilia; at the renal end of the tips there are cells with extraordinarily long cilia.

The author concludes with some observations on the morphology and physiology of the organ of Bojanus. In the Acephala the organ is in close relation with the posterior adductor and the gills; in those species (e. g. in *Pecten* and *Cardium*) in which the longitudinal axis is short, the organ is saccular and lies in the space between the pericardium and the posterior adductor; but when the body is long, as in *Anodonta* or *Mytilus*, the organ extends almost the whole length of the gills; these facts lead us to suppose that the primitive position of the organ was between the pericardium and adductor. The history of its development shows that the first portion of the organ was the ciliated funnel or tip of the kidney; the second, the true kidney formed of sac and loops; the various coils seen in *Cyclas* are in *Anodonta* replaced by coils which are simpler but rich in folds. The points made out by Ziegler are intelligible if we suppose that the ureter has an ectodermal origin.

There can be little doubt of the renal function of the organ of Bojanus, but it is of interest to inquire whether it has any other functions —does it assist the circulation of the pericardial fluid or does it introduce water into the pericardium, and so into the whole vascular system? The former is possible, but the arrangement of valves is such as to prevent the entrance of water from without.

Repair of Test of Anodon.*—M. Moynier de Villepoix has made some experiments on the repair of the test of *Anodonta ponderosa*; he has removed from the edges or sides of the shell pieces sufficiently large to allow observation of the modifications which supervene. The subjects of the experiments were put in (1) a basin which communicated with the stream from which they were taken, or (2) water from the stream which was renewed every two days, or (3) water entirely deprived of carbonate of lime. In all cases the animal reformed the parts which had been removed.

In those in which the edge of the shell was removed the epidermis

* Comptes Rendus, cxi. (1890) pp. 203-6.

which forms numerous folds at the edge of the shell was destroyed before the ablation of the calcareous part. In all cases this epidermis was renewed; in animals preserved in their normal medium it had all its original characters; it was covered on its outer side by crystals formed of a calcareous but not carbonated substance; the crystals appear to be a product of the secretion of the elongated epithelial cells near which they are found, and appear to play the part of reserve-materials. In the animals kept in non-calciferous water there were young crystals, but they are less regular and not so numerous; the presence of these few crystals is easily explained; the shell of the animal after four months' stay in the water had become completely transparent and so soft that, though still calcareous, it could be folded under the fingers like an elastic membrane.

In all the specimens examined there had been a secretion of a substance destined to close the wound made on the shell. This layer was formed of several organized membranes, placed on one another, arising at some millimetres from the edge of the wound and all around it. At its surface and between the membranes which form it, the calcareous matter takes on very various forms. Rhombohedra, radiated crystals, or crystalline plates were all seen; but in the animals which were preserved in the chalkless water there were no crystals of any kind.

The pallial epithelium was led by the necessity of an active secretion to undergo profound modification. The cells are greatly elongated and provided with a large oval nucleus in which are one or two highly refractive nucleoli; the protoplasm of the outer part of the cell is very granular and becomes stained green with methylene; it is, in fact, identical in form and reactions with the glandular epithelia of the fold of the mantle-lobe and of the dorsal region.

The author concludes that these observations show that the shell of these animals is a secretion-product of the mantle, that the earliest stage of the test is always a purely organic formation, and that the lime which strengthens the shell is obtained from the surrounding medium.

Molluscoida.

γ. Brachiopoda.

Stratigraphical Distribution of Deep-Sea Brachiopods.*—MM. P. Fischer and D. P. Oehlert report that the expeditions of the 'Travailleur' and 'Talisman' dredged sixteen species of deep-sea Brachiopods. Thirteen of these have been found in the marine pliocene deposits of Sicily and Calabria; since the period of these deposits these species have become extinct in the Mediterranean while almost identical forms to them have been perpetuated in the Atlantic; three other species appear to be in course of extinction, as isolated valves were alone dredged from the Mediterranean, while the forms are still abundant in the Atlantic.

The authors ask why there should be this tendency to the disappearance of abyssal forms from the Mediterranean, and correlate it with the gradual heating of that sea, which is, as compared to the Atlantic, closed. These considerations seemed to confirm the hypothesis that the

* Comptes Rendus, cxi. (1890) pp. 247–9.

distribution of marine animals is chiefly regulated by temperature. We may suppose that abyssal forms will become extinct in the Mediterranean and that their place will be taken by forms occupying more shallow waters and better adapted to higher temperatures.

Arthropoda.

Signification of Vitelline Cells in Tracheata.*—Mr. W. Schimkewitsch points out that in Amphibia and several Tracheata the cavity of the mesenteron is surrounded by elements of two kinds—the cells of one side are deprived of vitellus, while those of the other are true vitelline cells. These latter are differentiated in very early stages, sometimes during the segmentation of the egg; they may take part in the formation of the epithelium of the mesenteron. It is very probable that in those Tracheata in which the rudiment of the internal lamella, formed by invagination, is destined entirely for the formation of the mesoderm, that the epithelial layer of the mesenteron is developed exclusively at the expense of the vitelline cells. These cells in Amphibians and Tracheates are elements which long preserve their embryonic character, but from the morphological point of view they belong to the endoderm. It remains to be seen whether they are comparable to the vitelline nuclei of other Vertebrates.

α. Insecta.

The Retinal Image of the Insect Eye.†—Prof. Exner believes that he has been able to settle the controversy as to whether creatures provided with facetted eyes see by one erect image or by many inverted ones, in favour of the first hypothesis. In the case of the glow-worm (*Lampyris splendidula*), he has succeeded in demonstrating this erect image, and has shown that the dioptric apparatus of the eye is of such a kind that the distance of the image from the refracting media increases with the distance of the object from the eye. The two focal points lie on the same side of the refracting media, and by transmission of the rays in the opposite direction, a virtual inverted image is produced, which has the same position with regard to the refracting media as the erect image. The eye has no optic axis in the ordinary sense of the word, and the retinal image lies on a spherical surface parallel to the outer curvature of the eye.

It was in 1826 that J. Müller proposed his theory of the erect retinal image in the insect eye. According to this theory each element or facet consists of a transparent tube, coated with black pigment. These tubes are arranged in radial position on a hemisphere. Thus for each tube only rays incident in the direction of the radius can reach the retina at the extremity, while rays at any other incidence are absorbed by the pigment. An erect image is accordingly formed on the hemispherical convex retina at the base of the tubes. This theory was supposed to have been refuted by the observation made by Grüel and Gottsche, that, under certain conditions, an inverted image corresponding to each facet of the eye of a fly could be seen under the Microscope.

* Zool. Anzeig., xiii. (1890) pp. 399–402.
† SB. K.K. Akad. Wiss. Wien, xcviii. (1889) pp. 13–65, 143–51 (3 pls. and 7 woodcuts).

Fr. Boll, however, nineteen years after them, finding that the rods of the retina of the Triton gave inverted images, called in question the functional importance of these images, and once more directed attention to Müller's theory. Grenacher followed in the same direction, and lastly, Exner proved by *Hydrophilus piceus* that the image of Gottsche cannot be produced in the living animal, for it could not possibly lie in the position accorded to it by theory.

The author's recent observations were made exclusively on the eye of the male *Lampyris splendidula.* In this there is a fusion of the crystalline cones with the cornea, so that it is possible to wash away the pigment and the soft parts of the eye, and to examine the whole dioptric apparatus in the normal relation of the crystalline cones to the corneal facets. The eye was mounted in glycerin of refractive index 1·346 (that of the blood of *Hydrophilus piceus*), in such a way that the convex cornea was in contact with air, the crystalline cones with a fluid of approximately the same refractive index as the glow-worm's blood. Under the Microscope, with low powers, an erect image is seen of an object placed between the Microscope mirror and the eye. The sharpness of the images given by a fresh eye was extraordinary. A less perfect image of an arrow was given by an eye which had been kept in spirit 4–5 months. It measured 0·24 mm., while the length of the arrow was 32 cm., and its distance from the preparation 52 cm. The distance between the ends of the crystalline cones and the retina was determined by adjustment of the Microscope to be 0·23 mm.

When the position of the eye on the stage was inverted, so that the concave side was turned towards the object, an image was observed which was approximately in the same position as the normal retinal image, and had the same magnitude, but was inverted. Numerous observations and experiments were made in order to determine the path of the rays in the eye necessary for an erect image.

Directing the Microscope on the centre of the line joining two flames and adjusting on the plane of the retinal image, two light-points were seen. By approaching the focal plane towards the cornea it was determined that two rays come from each crystalline cone, one from the right object-point being deflected to the right image-point, while the other from the left object-point is in the same crystalline cone deviated to the left image-point. Thus it was found that a ray entering the crystalline cone at an angle makes an angle with it on emergence, and is on the same side of the axis, and in the same plane.

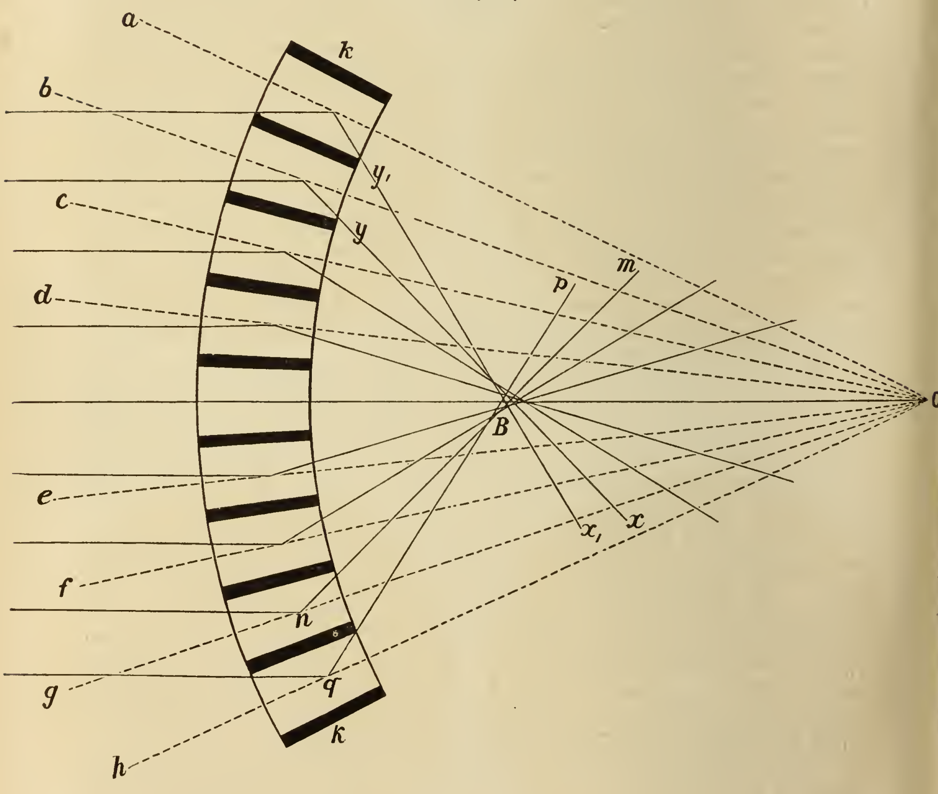
Fig. 61 shows the path of the rays for a single light-point at such a distance that the rays are approximately parallel. *k k* represent the facets, O *a* to O *h* their axes; the parallel rays are deflected in the crystalline cones so as to form the image at B. O is the centre of curvature of the eye. Similarly an image would be formed of another object-point lying for example in the direction O *b*, and it is clear that the total image would be erect.

Fig. 62 represents the image obtained when the Microscope is adjusted on a plane in front of the cornea. This gradually passes into that of fig. 63, when the focal plane is moved back until in the neighbourhood of the vertices of the crystalline cones. On moving the focal plane still further back, the bright circles of fig. 63 become

narrower, and finally the image shown in fig. 64 is obtained. Fig. 65 shows the appearance when the focal plane is behind the retinal image.

The author's experiments lead to the conclusion that the dioptric apparatus of the *Lampyris*-eye is very similar in its effects to a system of two lenses on the same axis which are separated by a distance equal to the sum of their focal lengths. In the *Lampyris*-eye the two convex

Fig. 61.



lenses are replaced by two cylindrical lenses, the Linsencylinder of Exner, which form the crystalline cone. The path of two pencils in a crystalline cone, according to this principle, is shown in fig. 66. The inverted image $a_2\,b_2$ of the distant object $a\,b$, which gave rise to so much confusion in the physiology of the compound eye, is formed not at the vertex or behind the cone, but in front, where there can be no nerve-fibres. The rays m and n proceeding from a form an image at a_1; similarly the rays p and q from b form an image at b_1. The image $a_1\,b_1$

is formed between the focus on the hinder part of the crystalline cone and its vertex, so that the rays m, n from a_1, on leaving the cone, are slightly divergent. Thus $a_1\ b_1$ gives rise to the virtual image $a_2\ b_2$. The figure shows how the angle of emergence of a pencil to the axis is on the same

Fig. 62.

Fig. 63.

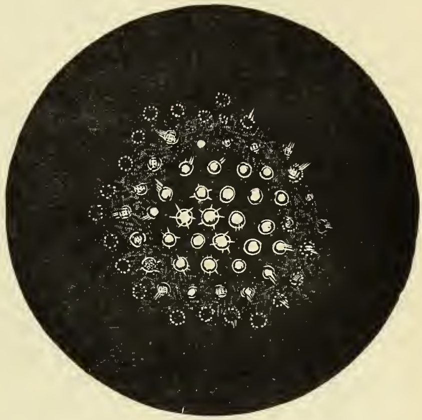
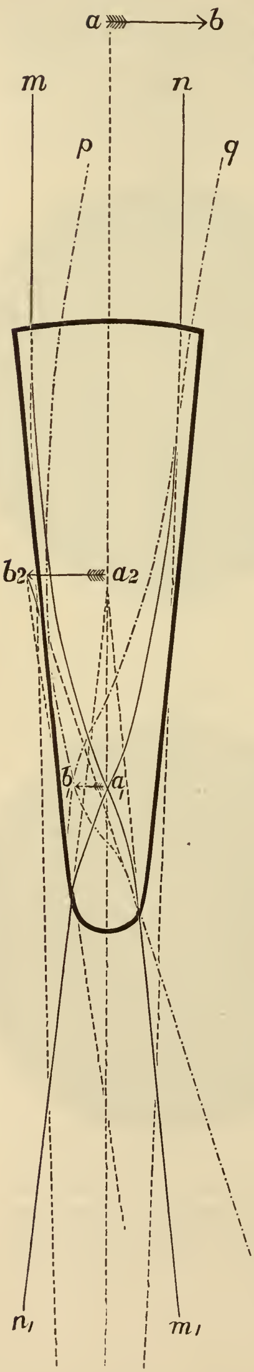


Fig. 64.

Fig. 65.

side as the incident pencil, and that it is so much greater, as the incident angle is greater. The author has constructed a model of an insect eye on the above principles. It consists of ten pairs of convex lenses, each of focal length of 2 in. The two members of each pair are separated by

Fig. 66.



4 in., and the ten sets are arranged on an arc of 75 cm. radius. The formation of the inverted image which is seen when the concave side of the *Lampyris*-eye is turned towards the object is explained by fig. 67. The crystalline cone acts like an astronomical telescope adjusted for infinite distance. The deviation which a ray undergoes is shown in fig. 68.

$$a\,b = a\,h_1 \tan\alpha = a\,h_2 \tan\beta.$$

Denoting the focal lengths $a\,h_1$, $a\,h_2$ by ϕ_1, ϕ_2

$$\frac{\tan\alpha}{\tan\beta} = \frac{\phi_2}{\phi_1} = \text{const.};$$

or, $\phi_1 \sin\alpha = \phi_2 \sin\beta$ since α, β are small.

The rays incident on the eye will be deflected in each crystalline cone according to the above law, and by means of it the calculation of the image, optical constants, &c., follows in a way strictly analogous to that of an ordinary lens.

Let $b\,c$ (fig. 69) be the curvature of the eye, $a\,p$ a radius from the centre of curvature a, $p\,c$ a ray from the point p, which is deflected to d.

Then by the above law,

$$\frac{\phi_2}{\phi_1} = \frac{\sin p\,c\,d}{\sin q\,c\,a} = \frac{\sin p\,c\,a}{\sin q\,c\,a} = \frac{\dfrac{\sin p\,c\,a}{\sin c\,a\,p}}{\dfrac{\sin q\,c\,a}{\sin c\,a\,p}} = \frac{\dfrac{a\,p}{c\,p}}{\dfrac{a\,q}{c\,q}},$$

$$\therefore \quad \frac{\phi_2}{\phi_1} \cdot \frac{c\,p}{c\,q} = \frac{a\,p}{a\,q}.$$

For rays near b

$$\frac{c\,p}{c\,q} = \frac{b\,p}{b\,q} = \frac{f_1}{-f_2}.$$

$$\therefore \quad \frac{\phi_2}{\phi_1} \cdot \frac{f_1}{-f_2} = \frac{a\,p}{a\,q} = \frac{f_1 + r}{r + f_2}$$

which leads to the equations

$$\frac{\phi_1}{f_1} + \frac{\phi_2}{f_2} = \frac{\phi_1 + \phi_2}{r}$$

$$\frac{\phi_1}{g_2} + \frac{\phi_2}{g_1} = \frac{\phi_1 + \phi_2}{-r}$$

where g_1, g_2 denote $a\,p$, $a\,q$.

Fig. 67.

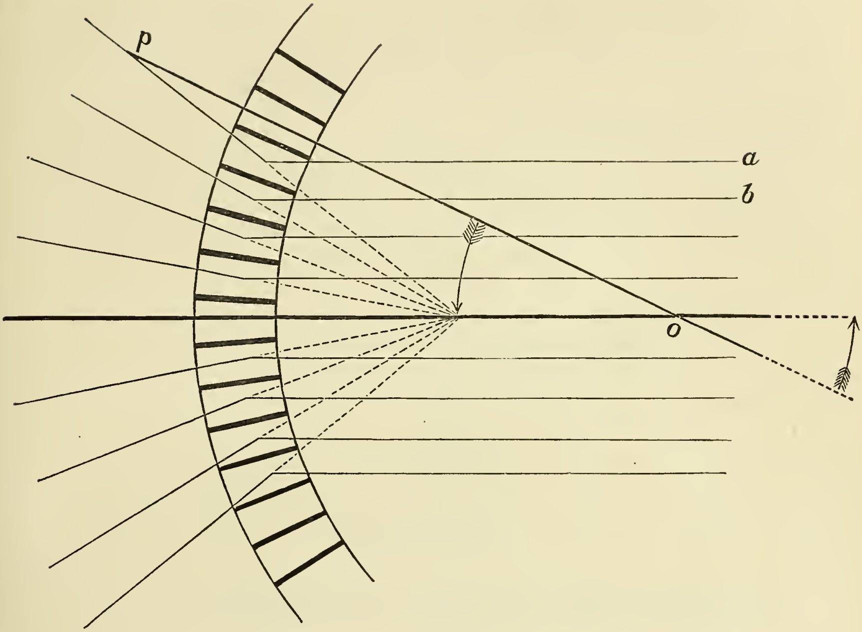


Fig. 68.

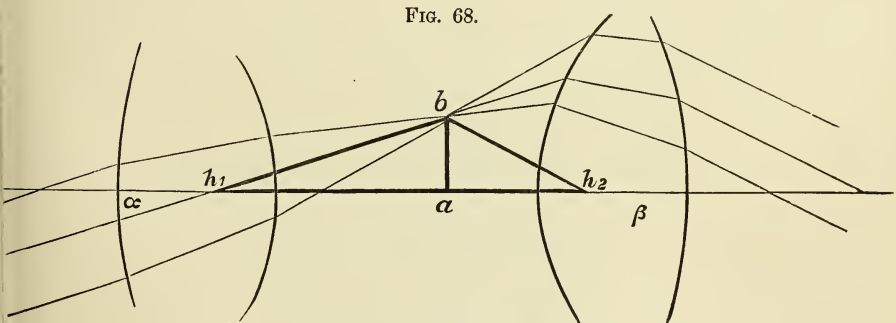
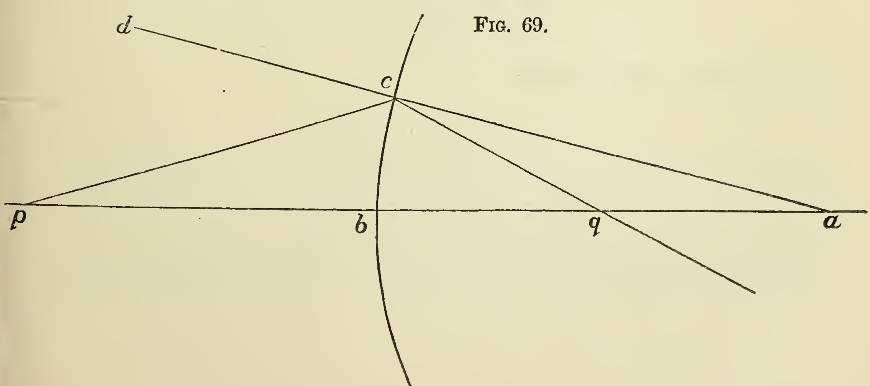


Fig. 69.



Then for $f_1 = \propto$ and $g_1 = \propto$

$$F_2 = \frac{-r\phi_2}{\phi_1 + \phi_2} \quad \text{and } G_2 = \frac{r\phi_1}{\phi_1 + \phi_2},$$

and for $f_2 = \propto$ and $g_2 = \propto$

$$F_1 = \frac{-r\phi_1}{\phi_1 + \phi_2} = -G_2$$

$$G_1 = \frac{r\phi_2}{\phi_1 + \phi_2} = -F_2.$$

Finally, eliminating r by means of

$$r = G_1 + G_2 = -(F_1 + F_2),$$

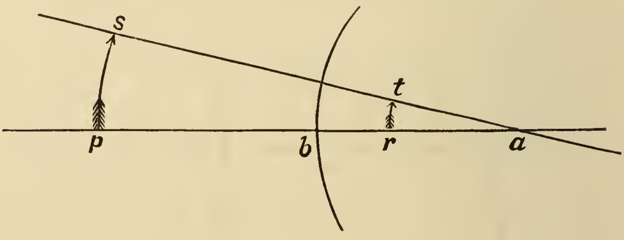
we have

$$\frac{F_1}{f_1} + \frac{F_2}{f_2} = 1$$

$$\frac{G_1}{g_1} + \frac{G_2}{g_2} = 1.$$

As regards the size of the image, we have from fig. 70,

Fig. 70.



$$\frac{\beta_1}{\beta_2} = \frac{p\,s}{r\,t} = \frac{a\,p}{a\,r} = \frac{g_1}{g_2},$$

and from the above equations

$$\frac{\beta_1}{\beta_2} = \frac{g_1 - G_1}{G_2} = \frac{G_1}{g_2 - G_2}$$

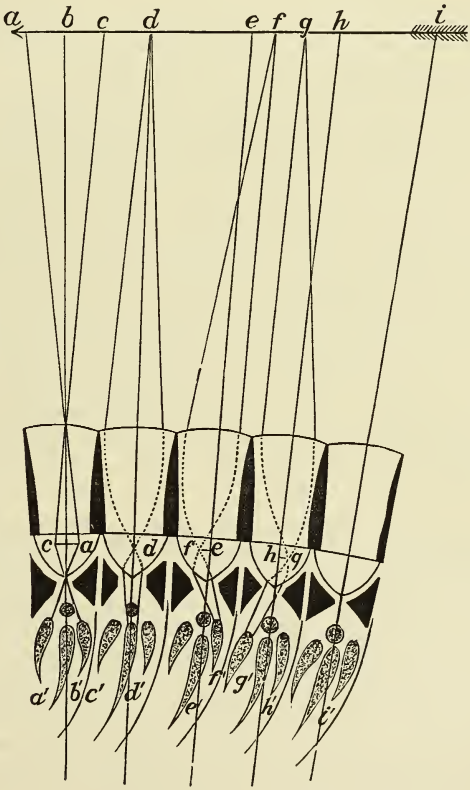
$$\frac{\beta_1}{\beta_2} = \frac{F_1 - f_1}{F_1} = \frac{F_2}{F_2 - f_2}.$$

The formation of the image in the *Lampyris*-eye may be looked at in

a somewhat different way. Each facet acting as an astronomical telescope may be considered as imprinting an image on the retina. Thus for each point of the object there will be a "summation image," consisting of about thirty superposed images.

On seeking to apply the principle of the image formation in the *Lampyris*-eye to insect eyes in general, a difficulty arises owing to the fact that in many the space between the crystalline cones and the retina is for the most part filled with black pigment instead of with transparent material as in the *Lampyris*-eye. Now it is known that the pigment of the Frog's retina is by illumination driven forward between the rods so

FIG. 71.



as to separate the individual retinal elements, but that in the dark it passes back to the choroid, leaving the retina free. The author therefore supposes that in the insect eye a similar phenomenon takes place, and that the pigment regulates the brightness of the retinal image in a way analogous to that of the iris. This theory was put to the test in the case of *Hydrophilus piceus*, *Dyticus marginalis*, and *Colymbetes fuscus*.

Two specimens were taken, one killed in bright sunshine, the other in the dark. The author gives figures showing (1) a section of the eye of *Hydrophilus piceus* taken in the dark, in which the crystalline cones may be seen to be thickly coated with pigment, but to have ends free, and the space between them and the retina clear; (2) a section of the illuminated eye has the spaces between the cones poor in pigment.

Other figures represent a crystalline cone of *Dyticus marginalis*. By the effect of the pigment the summation image, instead of consisting of thirty or more images, is made up of only a few. It may be even so far reduced that each point of the object is depicted only by one facet.

Fig. 71 shows a number of facets of a *Ctenophora flaveolata*, in which the retinula, consisting of seven cells, is separated from the dioptric part of the facet by pigment in such a way that light can only reach the retinula through a narrow opening. Supposing the dioptric apparatus of each facet to act, as in the *Lampyris*-eye, as an astronomical telescope, there results an erect image as seen from the figure.

As regards the accommodation of the *Lampyris*-eye, the forward displacement of the image corresponding to the approach of the object was in one case measured. It amounted to 0·092 mm., when the object was moved from a distance of 810 mm. to that of 1·2 mm.

Secretion of Silk in Bombyx mori.*—M. R. Dubois discusses the mode of coagulation of the silk-secretion. He comes to the conclusion that it is not comparable to that caused in white of egg either by alcohol or heat, but to the coagulation of blood or muscular fluid. A sort of serum or sericigenous plasma may be easily obtained by macerating silk-glands, for two or three days in a cool place, with distilled water, water containing 4 per cent. of salt, or, still better, with a 15 per cent. solution of carbonate of potash. This serum will give a coagulum without the addition of any reagent, and, when still moist, has the ductility and elasticity of freshly-formed silk, but it soon loses its property of being drawn out into threads. As with the coagulation of blood, the formation of silk-clot is favoured by oxygen.

Parthenogenesis of the Ova of Bombyx.†—Sig. E. Verson found that the development of unfertilized eggs of the silkmoth stopped, without power of further progress, after twenty-eight days, and that at a stage which corresponded approximately to the state of fertilized eggs three days after deposition. He also criticizes the methods and results of previous investigators of this case of parthenogenesis.

Anatomy of Sesia tipuliformis and Trochilium apiforme.‡—Prof. E. K. Brandt points out that the anatomy of the Clear-wings is particularly interesting, as these moths exhibit obvious mimicry. It is probable that the Clear-wings are ancient forms which have lately acquired a special adaptation to (or mimicry of) other flower-frequenting Insects. The proboscis of *Sesia tipuliformis* is moderately developed, but very weakly constructed; the nervous system is arrested in develop-

* Comptes Rendus, cxi. (1890) pp. 206-7.
† Bull. Soc. Entomol. Ital., xxi. (1890) pp. 118-23.
‡ Horæ Soc. Entomol. Ross., xxxii. (1889) pp. 41-9. See Ann. and Mag. Nat. Hist., vi. (1890) pp. 285-90.

ment; the digestive apparatus "represents about half the usual development in typical Lepidoptera." The ovary of *S. scoleciformis* is remarkable for containing seven, in place of four, egg-tubes. In *Trochilium apiforme* the skeleton and the nervous system exhibit the same peculiarities as in *Sesia*, and the same is largely true of many of the other organs.

Sculpturings on Elytra of Coleoptera.*—Herr A. von Bonsdorff finds that the variations in the different sculpturings on the elytra of Coleoptera are almost endless; sometimes a type is constantly predominant in a group (Elateridæ), while at others there may be within narrow limits (*Carabus*) so great variation that scarcely two species can be found to exhibit the same structure. Three chief types may be recognized:—

A. Primary costæ present, areas undivided. The costæ may be elevated greatly (*Carabus nitens*) or only slightly (*Silpha obscura*) above the surface of the wing. In the areæ the network may be seen as such (*Chrysochroa vittata*), or be wrinkled (*Hammatoceros hæros*), or compressed to more or less deep dots (*Necrophorus germanicus*).

B. The areas are divided into two. The primary are better developed than the secondary costæ (*Anthia 10-guttata*), or resemble them, when they are only separated by rows of dots or depressed lines (*Amara*, *Gyrinus*, *Passalus*).

C. The areas are divided into four parts. In this type the primary are often not better developed than the secondary costæ.

In each type there are forms in which the elytra tend to become almost smooth; *Silpha obscura* may be compared with *S. lævigata*. The regular costæ also tend sometimes to break up.

Germinal Vesicle of Flies.†—Dr. P. Mayer is of opinion that the structures described by Mr. B. T. Lowne as germinal vesicles ‡ are the chitinogenous vesicles which are so often found in the glands of Insects; a reference to Leydig's work in 1859 would have prevented the perpetration of this mistake.

British Phytophagous Hymenoptera.§—Mr. P. Cameron has published the third volume of his valuable work on these insects, in which he deals with the Cephidæ, Siricidæ, Oryssidæ, and the parasitic Cynipidæ. With another volume he hopes to be able to complete his undertaking.

Viviparous Caddis-fly.‖—Prof. J. Wood-Mason has observed the exit from the extremity of the abdomen of a Caddis-fly of innumerable tiny living creatures. These were Trichopterous larvæ, which possessed all the characters—slender and tapering body, laterally expanded and dorsally humped first abdominal segment, and disproportionately long and slender third pair of legs—of typical Leptoceridæ; no tracheal gills could be detected. The abdomen of the mother retains after preservation in spirit the distended condition it had before parturition, and has the

* Zool. Anzeig., xiii. (1890) pp. 342–6. † T. c., pp. 367–8.
‡ See this Journal, *ante*, p. 170.
§ 8vo, London, 1890 (Printed for the Ray Society), 274 pp., 17 pls.
‖ Ann. and Mag. Nat. Hist., vi. (1890) pp. 139–41.

form of a thin and transparent membranous sac; the four penultimate abdominal segments appear to be extended and stretched to the limit of the extensibility of all their interarticular membranes, and the posterior half of the abdomen appears, therefore, to be the region which gives lodgment to the main mass of the brood-pouch. The arrangement is much more like that of the white-ant queen than of the viviparous Coleoptera. The species belongs to the genus *Notanatolica*, and may be called *vivipara*. The nature of the brood-pouch, the habits of the larvæ —whether aquatic or terrestrial—the male, and the form of the larva-case, are important points as to which information is desirable.

Ovarian Envelope of Phyllium.*—M. L. F. Henneguy has examined the structure of the envelope of the ova of this orthopterous insect. The egg of *P. crurifolium*, from the Seychelles, measures 5·5 by 4 mm., and a vertical section, under a low power, is seen to consist of three zones; the outermost is formed by large, irregular alveoli; the median by thick, parallel fibres, which are set perpendicularly to the internal surface; the innermost zone is compact in structure and striated. The outermost layer is very thick in the wings of the capsule which it forms entirely, and much thinner in the interalar spaces. It and the median zone represent the exochorion of authors, while the innermost corresponds to the endochorion. It is but rarely that the alveoli have the pentagonal or hexagonal form described by Murray and Joly; their walls, the thickness of which is not constant, are formed of a homogeneous substance of a chitinous nature; the alveoli are filled with air, and contain no traces of protoplasm. The median zone, which does not seem to have been seen by Murray or Joly, is characterized by short fibres, equal in thickness, and set parallel with one another. The innermost zone has the most complex structure, for four or five different layers can be made out in it. The most external layer is very delicate, and homogeneous, and is set against the layer on the surface of which are implanted the fibres of the median zone. Next there is a layer which is finely and regularly striated, and the striæ are perpendicular to the preceding layer; this may, indeed, be divided into two layers, for the outer part remains colourless while the inner becomes rosy on treatment with safranin. These are followed by an irregularly striated layer, and this by one which is homogeneous. The second and third layers have a very remarkable crystalline structure; when examined with polarized light they exhibit double refraction. They are very fragile, and break easily under the razor; the lamellæ thus formed have a calcareous appearance, but are insoluble in acids; on treatment with potash the only apparent alteration is the loss of the double refraction. It would be very interesting to study, from the histological point of view, the structure of the egg-capsule of different Phasmidæ, and the mode of formation in the genital passages; it is difficult to conceive how so complex a tissue can be secreted by the walls of the oviduct and the ovigerous sheaths.

The author repeatedly compares the egg to vegetable seeds, and he points out the interest of the fact that while the adult insect exhibits a mimicry of parts of plants the egg should do so likewise.

* Bull. Soc. Philom. Paris, ii. (1890) pp. 18–25.

δ. Arachnida.

Embryology of Euscorpius italicus.*—Mr. M. Laurie has investigated the development of the Scorpion, on which no detailed work has been done for twenty years. It is exceptional among Arthropods in that the whole development takes place within the ovarian tubes, and the history does not agree with any other Arachnid type as yet described. The development of the eye has been accurately worked out by Parker, but the author has been able to add details as to the earlier stages and as to the connection of the eyes with the cerebral invagination. The author's observations confirm the conclusions of Lankester and Bourne, but afford no support to the views of Patten.

The mode of formation of the ventral nervous system is exceptional among Invertebrates, and resembles rather that of the Chordata, for the nerve-chord, instead of peeling off from the superficial layer of epiblast, sinks down bodily, and is covered by a layer of epiblast which grows over it from each side. From the history of its development there can be little doubt that the coxal gland is a nephridium, and it seems probable that the genital tubes are, in part at least, nephridial. The gill-books are undoubtedly comparable to the abdominal appendages of *Limulus*, but their mode of origin is still open to some doubt. The author thinks it quite conceivable that there have been changes in the conditions of development, due to terrestrial life and the consequent pressure on the embryo.

The mesoblast consists at first of a pair of segmented bands with a separate cœlomic space in each somite and also one in the cephalic segment. The cœlomic spaces soon unite, and the mesoblast bands join across the ventral surface. Later on, they extend round—the cœlomic space extending with them—and unite in the middle line on the dorsal surface, where a thickened band gives rise to the heart. A portion of the cœlom in the seventh segment becomes separated off to form the genital tubes. The outer layer of the mesoblast forms chiefly the muscles of the body, while the inner layer becomes folded so as to surround the liver and intestine, and the cœlomic space becomes partly filled up by trabecular tissue.

American Spiders.†—Dr. Henry M'Cook has nowhere shown the thoroughness and enthusiasm of his study of animals more happily than in this valuable work. The first volume of the book is all that is at present published; and, considering the scheme of the whole work, we should have preferred to see the last or third volume first; that volume will treat systematically of the spider fauna, especially the Orb-weavers of the United States. The European reader is unable to follow as intelligibly and with as much interest as he otherwise would, for want of certainty about the specific character and geographical distribution of several of the forms, concerning which most interesting details are furnished.

That which distinguishes Dr. M'Cook's work is the completeness

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 105-41 (6 pls.).

† 'American Spiders and their Spinning Work. A Natural History of the Orb-weaving Spiders of the United States, with special regard to their industry and habits.' By Henry C. M'Cook. i., Philadelphia, 1889, sm. 4to, 369 pp., 354 figs. in text.

with which he has studied American spiders in their native haunts and normal habits. The anatomy and physiology of spiders is but lightly dealt with, and in no sense as the result of original investigation; but their habitats, their geographical distribution in the States, the characters of their snares, dens, nurseries, and hiding-places, and, above all, the manner in which the often exquisitely delicate but dynamically perfect snares are woven, are all presented with a clearness and originality which give this work on 'American Spiders' a distinctive place in the literature of this fauna.

The illustrations throughout the book are original, and to the outdoor student of spider-life are redolent of the heath, the hedge-row, and the river-side. They are what has been constantly looked for, but most sparingly provided, even by our best European authorities. A knowledge of the individual characters, and the anatomical distinctions of a form, justifying its position in a classification, have, as a rule, sufficed. Writing in regard to another group of spiders Mr. Moggridge says, "The *dwellings* of only eight out of thirty-six species of Trap-door stated by Prof. Ausserer to belong to the Mediterranean region, are known in books, those of the remaining twenty-eight being . . . yet to be discovered." * What Mr. Moggridge sought to do for this striking group Dr. M'Cook has done concerning the Orb-weavers of the United States, and has pointed out a mode of study which any intelligent naturalist may follow, and with patience be certain of securing most profitable results, not only in the accomplishment of his own object, but as an aid to other experts, for we believe it will be clearly shown that no classification of a spider fauna can be thorough which does not include a complete knowledge of the weaving habits of the genera and species.

Dr. M'Cook rejects the arrangement of the order Araneæ adopted by Blackwall, dividing the order into (1) Sedentary Spiders and (2) Wandering Spiders. In the former he includes (1) Orb-weavers; (2) Line-weavers; (3) Tube-weavers; and (4) Tunnel-weavers. In the latter are placed (1) Citigrades; (2) Laterigrades; and (3) Saltigrades.

But it is in the details of construction, as we have already hinted, that his original work is seen. The exact manner in which the bridges and scaffolding of silk are stretched across wide interspaces, and the viscid spirals laid in, is what was needed to inspire other minds to a like study. The "fenders" he so clearly indicates as forming part of "Argiope's snare," the adoption of means by the spider, which from an engineering point of view, obtain the greatest strength with the slightest means, all tend to present this group to the naturalist of the fields in a new light.

Dr. M'Cook must have enjoyed exceptionally fortunate opportunities to obtain such beautiful examples. Some of the snares which he figures of *Uloborus* are of extreme delicacy and beauty; the snare of the "Triangle Spider" and its mode of "operating" its snare are of much interest. So are his observations on the spinning work of *Hyptiotes* and the "Ray Spider." But he may be, as he has already been by those who have followed the reports of his work in America, congratulated on

* 'Trap-door Spiders,' p. 75.

his discovery, while studying the agricultural ants of Texas, of the remarkable domed snares of what he has designated *Epeira basilica*.

The second volume of this work is to deal with the courtship and mating of spiders, the early life and distribution of species, their senses and the relation of these to their habits, their enemies, and fossil spiders.

Habits of Mygale.*—Herr C. Grevé gives an account of the behaviour of a *Mygale*, which (along with four others, several millipedes, and a snake) was found at Moscow in the cavity of a log shipped from Honduras. After a voyage of some six months, the liberated spider showed a naturally large appetite, and devoured thirty cockroaches in ten days. Its hunger diminished, however, and for a while some enticement was requisite to arouse fresh appetite. Across the floor of the cage fine threads were spun on which the cockroaches were entangled. The spider's activity was emphatically nocturnal, for during the day it usually remained lurking in a hole. Herr Grevé observed it killing its prey, and noted that it sometimes left the corpses for future use. On the floor of the room it would run about like a mouse, and a morning douche-bath seemed to be enjoyed. Its power of vision was keen for objects above its eyes, but not for things on its own level. From his observations, Herr Grevé concludes that the spider lurks in holes for prey entangled in the almost invisible snares spun round about. An unlucky fall injured his pet, and brought his interesting studies to an end.

Water-Mite Parasitic on a Snail.†—Herr F. Koenike has a preliminary notice of *Atax Ampullariæ* sp. n., a water-mite found living parasitically in the gills of a South American species of *Ampullaria*. Up till now species of this mite have been found parasitic only on Bivalve Molluscs.

ε. Crustacea.

Variations of Decapod Crustacea.‡—Mr. W. F. R. Weldon has investigated the average length of three or four organs which admit of accurate measurement, and the frequency with which the average length and every deviation from it occurred in one or two local races of *Crangon vulgaris*. The organs selected were four; the total length of the carapace; the distance from the posterior margin of the carapace to the front of the median spine; the length of the sixth abdominal tergum; and the length of the telson. Four hundred individuals were obtained from Plymouth Sound, three hundred from Southport, and three hundred from Sheerness. It was found that not only does the average size of the carapace differ in different local varieties, but the range of deviation from that average differs also. Nevertheless the frequency with which the observed deviations from the average occur is in all the three observed cases expressed by a curve of error; this was precisely the result predicted by Mr. Galton.

Results similar to the above have been obtained from measurements

* Zool. Jahrb., v. (1890) pp. 179–83.
† Zool. Anzeig., xiii. (1890) pp. 364–5.
‡ Proc. Roy. Soc., xlvii. (1890) pp. 445–53.

of a larger series of organs and parts of organs in *Pandalus annulicornis* (two races) and *Palæmon serratus* (one race), but not more than one hundred individuals of each race have as yet been examined, and the curves of distribution of the magnitudes of the various organs are therefore more irregular than those given for the shrimp.

Circulatory System of Carapace of Decapod Crustacea.*—M. E. L. Bouvier states that the afferent system of the membrane which lines the carapace in the branchial region arises from a large postcephalic lacuna which surrounds the liver and carapace; the efferent system consists of a well-defined trunk which follows the membrane close to the free border of the carapace; it increases in size from before backwards and opens directly into the pericardium at its posterior angle (*Astacus*) or at the sides. There is, in fact, a cutaneous respiratory apparatus analogous to that of *Mysis*, and it is the exaggeration of this arrangement which allows certain Crustacea, such as *Birgus latro*, to live for a very long time out of water.

In other words, the Schizopods and the abranchiate larvæ of Decapod Crustacea, have a purely cutaneous mode of respiration; in the adult Decapod this respiratory apparatus persists, and in some of its characters is constant; but to it there has been superadded a secondary respiratory apparatus, the branchial, and this is the only one which is, as a rule, described in our text-books.

Histology and Development of Eye of Lobster.†—Mr G. H. Parker gives an account of the minute structure and development of the eye of the Lobster. The ommateum, which lies between the corneal cuticula and the basement membrane, is composed of cells of the corneal hypodermis, cone-cells, distal retinulæ, proximal retinulæ and accessory pigment-cells, each of which the author describes in order. The view that the corneal cuticula is separated from the cone-cells by an intervening layer of cells is one which has been held only by recent investigators; though Claus suspected the presence of a corneal hypodermis he searched for it in vain. Each hypodermal square appears to consist of two flattened cells, triangular in outline and very intimately applied to one another on their longest sides. The author supports the view of Schultze and Grenacher that the cone-cells and rhabdoms are separate structures, and it is probable that in the crayfish, as in the lobster, the fibrous ends of the cone-cells terminate in the basement membrane. The distal retinulæ have not as yet been identified in the eyes of many Decapods, though Carrière has seen them in *Astacus*. In the region of the retina which lies between the proximal ends of the cones and the distal border of the deeper band of pigment, the groups of cone-cells and the pairs of distal retinulæ are separated by a considerable intervening space; the space is filled by a fluid which contains a very small amount of albuminoid substance; on coagulation it forms vesicular bodies of varying size, which usually become loosely attached to the cone-cells and the fibres of the distal retinulæ; they readily take up colouring matter, and it was probably these bodies which Newton described as the nuclei on the investing membrane.

* Comptes Rendus, cx. (1890) pp. 1211–3.
† Bull. Mus. Comp. Zool., xx. (1890) pp. 1–60 (2 pls.).

The proximal retinulæ are pigment-cells which closely invest the rhabdome. Accessory pigment-cells occupy the open space at the base of the ommatidia, and their function seems to be that of filling what would otherwise be an unoccupied space, as though they gave solidity to the tissue in the base of the retina; similar cells have been seen by Carrière in *Astacus*, and by Patten in *Penæus*. As the fibres of the optic nerve pass into the proximal retinulæ, it is most likely that the rhabdome and not the cone is the perceptive body; this conclusion is further supported by the ultimate distribution of the optic fibrillæ. The author shows that the cone-cells form a transparent axis which leads directly to the rhabdome, and through which light could readily have reached that structure, and it is, no doubt, in it that the light is transformed into that kind of energy which is transmitted by nerve-fibres.

In treating of the development of the eye of the Lobster, the author points out that four different types of structure have been indicated as possible by the work of various investigators. He is himself led to reject that of Patten as unsupported by embryology, while Reichenbach and Kingsley are said to have misinterpreted structures. On the whole, the balance of evidence seems at present to be in favour of the view that the retina originates as a thickened layer of hypodermis, and is not modified by any form of involution. When there is an involution it is connected only with the formation of the optic ganglion; and in the production of this ganglion, the involution can be replaced by a proliferation of cells. In Crustaceans the nerve-fibres are always attached to the proximal ends of the retinulæ, and we may, therefore, suppose that the retina has never been inverted, but retains its original position; any explanation which involves the inversion of the retina is, in all probability, wrong.

It is difficult to draw any general conclusion as to the number of retinulæ in the ommatidia of the higher Crustacea, but Herrick's statement that there are seven in *Alpheus* coincides fairly with the results obtained from the lobster. The author concludes with some discussion as to the types of ommatidia, in which he attempts to bring the ommatidia of all Crustaceans into relation by suggesting a process of cell-division, but the question of what constitutes the simplest form of ommatidium is one which still requires study.

Blastoderm of Isopoda.*—M. L. Roule describes the formation of the blastoderm in *Porcellio scaber* as a twofold process:—(1) The peripheral differentiation of the deutoplasm, under the influence of the nucleated "islet," into a formative layer; and (2) the successive nuclear divisions which establish the blastoderm. The deutoplasm is in no sense nucleated; all the nuclei of the blastoderm are derived from the segmentation-nucleus; the nuclei of the "vitelline cells" of other investigators are, like those of the embryonic body, derived from the nuclei of the blastoderm accounted for above.

The Oxycephalids.†—Under this title Mr. C. Bovallius has published a memoir on these Amphipoda. He discusses the principles

* Comptes Rendus, cx. (1890) pp. 1373–4.
† Nova Acta Reg. Soc. Sc. Upsal., iii. (1890) 141 pp., 7 pls., and 87 figs. in text.

of classification of the Amphipoda Hyperiidea; gives morphological notes on the group he has especially studied, and concludes with a monographic account of the genera and species of the Oxycephalidæ, in which there are ten genera, and the Xiphocephalidæ, in which there is only one.

Bosmina.*—Dr. O. E. Imhof makes an appeal for specimens of species of this genus of the Cladocera, of which he proposes to write a monograph. Twenty-nine species and four varieties have already been described, and it is important to have exact information as to their geographical distribution.

Organization of Cyprides.†—Prof. C. Claus has taken up the study of *Cypris*, as no sensible addition to our knowledge of the Cyprides has been made since 1854, when Zenker published his monograph. The ventral nervous cord is elongated, and contains five pairs of ganglia. The anterior portion of the brain gives off nerves to the tripartite frontal eye, and has a particularly strong coating of ganglionic cells. The frontal eye has three closely connected pigment-cups, each of which is occupied by some sixteen to twenty cells, into which the nerve fibres enter, beneath a nearly spherical lens.

The endoskeleton is represented by a broad, indistinctly bipartite, chitinous plate, to which pairs of muscles for all the limbs of the trunk, as well as the second pair of antennæ are attached. The alimentary apparatus commences with a rather narrow atrium. Zenker's "rake-like masticating organs" are situated at the bottom of this atrium, and belong, as a sort of hypopharynx, to the labium. The gizzard is not, as Zenker supposed, free, for its larger hinder portion is united with the intestine; the smaller anterior portion is capable of a forward and backward displacement which calls to mind the motor mechanism of the gizzard of the Decapoda; but it affects only the dorsal wall, the strong convexity of which projects into the lumen, beset with rows of pointed teeth, and acts like a rasp against the concave ventral wall, which is also densely armed with points. The mid-intestine is divided by a deep constriction into two sections, the anterior of which surrounds the throat-like opening of the gizzard, and gives off two hepatopancreatic tubes into the interspace of the fold of the shell. It contains a very deep glandular epithelium, and must, as the stomach, have the function of digesting albuminous foods.

Both the antennary gland and the gland of the second pair of maxillæ are well developed in *Cypris*, but the former is placed in the shell-cavity, and must, therefore, be called the shell-gland. The gland-duct consists only of a series of perforated cells, the nuclei of which are of enormous size, and emit above and below digitiform branches, each of which represents only a single perforated cell.

The complicated penis represents a metamorphosed pair of limbs, while the external genitals of the female are probably the basal joints of a pair of limbs. The oviduct is much coiled, and the duct of the receptaculum is spirally twisted like a watch-spring.

* Zool. Anzeig., xiii. (1890) pp. 359–61.

† Anzeig. K.K. Akad. Wiss. Wien, 1890, pp. 1–6; see Ann. and Mag. Nat. Hist., vi. (1890) pp. 108–12.

Ostracoda from South Sea Islands.*—Prof. G. S. Brady has a report on the Ostracoda collected by Dr. H. B. Brady in the South Sea Islands. Very little is as yet known as to these Crustaceans from the region where this collection was made. Various Cypridinidæ were found to be abundant between tide-marks, whereas in the northern hemisphere no members of the family have, except on one occasion, been taken except by the dredge or in the tow-net over deep water. More than eighty species are reported on, a large number of which are new; *Pleoschisma* and *Streptoleberis* are new genera of Cypridinidæ.

Vermes.

α. Annelida.

Occurrence of Pelagic Annelids and Chætognaths in St. Andrews Bay throughout the Year.†—Prof. W. C. M'Intosh continues his account of the fauna of St. Andrews Bay. The only adult pelagic forms are *Autolytus* and the sexual forms of the Nereides. The rest are larval, postlarval, and young stages of Annelids; they often occur in large numbers, and probably exercise an important function in connection with the food of postlarval and young fishes. As in some other groups larvæ of the same species are found during several months. *Tomopteris*, formerly considered somewhat rare, is a form which frequents the inshore waters from January to December. Chætognaths exist in enormous numbers, and in some inshore areas the bag of the large midwater-net is distended with a semi-solid mass of them.

The author deals with the months of the year in order. In July there is a decided increase in the number of pelagic larval Annelids; the most abundant were the postlarval forms of *Spio*, *Polydora*, and *Nerine*, but in August the larval Annelids attain their maximum. In November and December there is a marked paucity of Annelidan life, but the *Sagittæ* were remarkably numerous and large.

Polychæta Sedentaria of Firth of Forth.‡—Messrs. J. T. Cunningham and G. A. Ramage have published the notes and drawings made by them when studying the sedentary polychætous worms at the Granton Marine Laboratory.

Arenicola cristata and its Allies.§—Mr. J. E. Ives thinks that *Arenicola cristata* is found in the Mediterranean as well as in the West Indies and North American seas, and that the sixteen species described may be reduced to three—*A. marina*, *A. ecaudata*, and *A. cristata*.

Hekaterobranchus Shrubsolii.‖—Miss F. Buchanan gives an account of this new genus of the Spionidæ, which is found in soft mud at Sheppey. It receives its name from the fact that two kinds of branchial organs are present, and that there is a single pair of each kind. A single pair of dorsal branchiæ, very large, is found on the first segment; the cephalic tentacles are not grooved, but ciliated all over. The prostomium is well developed and bears four eyes; the first segment is

* Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 289-525 (4 pls.).
† Ann. and Mag. Nat. Hist., vi. (1890) pp. 174-82.
‡ Trans. Roy. Soc. Edinb., xxxii. (1888) pp. 635-84 (12 pls.).
§ Proc. Acad. Philadelphia, 1890, pp. 73-5.
‖ Quart. Journ. Micr. Sci., xxxi. (1890) pp. 175-200 (2 pls.).

prolonged forwards on the ventral surface to form a collar. The pharynx is eversible and richly ciliated; there is a single pair of thoracic nephridia which open to the exterior in the second segment, reach back into the sixth, and then bend forward again. The giant fibres are minute, and there is in each nerve-cord one near the upper and inner surface. The dorsal "cirri" form a sort of collar in the second segment.

Classification of Earthworms.*—Dr. W. B. Benham has published an interesting "attempt to classify earthworms." He begins by offering some suggestions as to the nomenclature of certain organs. He proposes to use the term "couple" in place of "pair" when speaking of the arrangement of the setæ which is found in *Lumbricus*, and in place of "dorsal" and "ventral" to use "outer" and "inner." He regards the peristomium as the first somite. In referring to the position of an aperture between two somites he uses the form x/xi. When the "clitellum" is equally developed all round the body it may be called the "cingulum." The terms "vesiculæ seminales" and "seminal reservoirs" are conveniently replaced by "sperm-sacs," the "receptacum ovorum" by "ovisac," and "vas deferens" by "sperm-duct." The term "capsulogenous gland" is misleading, and may be replaced by Vejdovsky's term "albumen-gland." Such anterior nephridia as are used, not for excretory purposes, but for softening or otherwise acting on the food, may be called "pepto-nephridia," and they are either intra-buccal or extra-buccal.

In the alimentary canal the following regions may be distinguished: buccal region, pharynx, œsophagus, gizzard, tubular intestine, and saccular intestine; there are often two or more gizzards, and in some cases there is none. The typhlosole is absent in a few cases only. The calciferous glands are very frequently absent, and when present are very variable in number and position.

The class OLIGOCHÆTA may be divided into two sub-classes, according as asexual reproduction is or is not effected.

Sub-class I. Naidomorpha.
  Order 1. Naidina, with the families Aphanoneura, Naididæ, Chætogastridæ, and the genus Ctenodrilus.
Sub-class II. Lumbricomorpha.
  Order 1. Microdrili (Lumbricomorpha minora), with the "families" (Vejdovsky) Discodrilidæ, Enchytræidæ, Tubificidæ, Phreoryctidæ, and Lumbriculidæ.
  Order 2. Megadrili (L. majora).

These may be divided into two branches, the first of which is called Plectonephrica, in consequence of the excretory system being in the form of numerous delicate tubules in each somite, which unite to form a network with more or less numerous external apertures; a large "nephridium" with cœlomic funnel may be present in addition to these tubules; in this are the families Typhœidæ, Acanthodrilidæ, and Perichætidæ.

In the second branch, that of the Meganephrica, the excretory network is absent, and replaced by a pair (rarely two pairs) of large

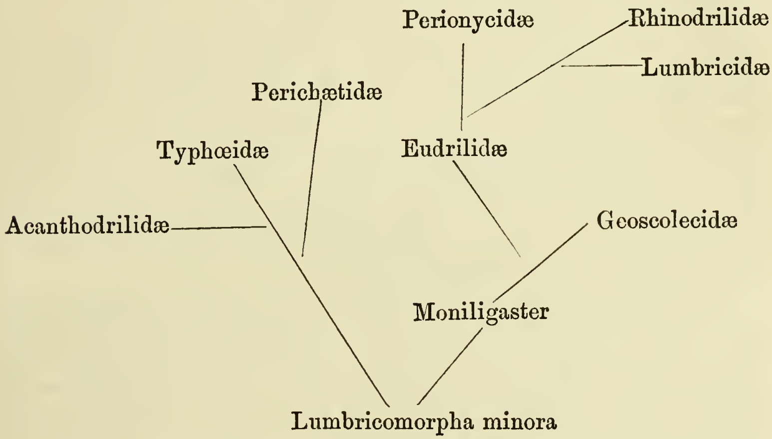
* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 201–315 (36 figs.).

nephridia in each somite. Here are the families Moniligastridæ, Eudrilidæ, Perionycidæ, Geoscolecidæ, Rhinodrilidæ, and Lumbricidæ.

The author next gives an account of the families and genera *in extenso*, and next a tabular summary of generic characters, with an index to the identification of genera.

An attempt is next made to discuss the phylogeny of the group of earthworms—the excretory system, the setæ, clitellum, prostate, and sperm-ducts may be taken as the more important characters.

The results arrived at are indicated by this phylum:—



Atrium or Prostate.*—Dr. W. B. Benham raises some objections to Mr. Beddard's suggestion that the "prostates" of many earthworms are homologous with the "atria" of the Tubificidæ and other freshwater Oligochæta. By the term prostate we ordinarily understand a glandular structure which secretes a fluid, which is utilized in some way or another —how is not thoroughly known in Oligochæta—in the process of copulation. It is admitted that the organs in question have some such function, and it seems better to retain the word prostate than to replace it by the ill-defined term atrium. Mr. Beddard, indeed, would seem to regard the epiblastic prostate of *Tubifex* as the homologue of the mesoblastic covering of the atrium of *Moniligaster*.

Anatomy of Moniligaster.†—Mr. F. E. Beddard gives an account of the structure of *Moniligaster*, which, in his opinion, is not an earthworm except in habit. It differs from all earthworms in the following points:— The vas deferens is single on each side; it only occupies a single segment, or at most two; there is only a single pair of testes; the sperm-sacs are a single pair with a simple cavity, that is, one not divided up by trabeculæ; the atrium opens on to segment x/xi, and its structure is that of the atrium of *Rhynchelmis;* the oviduct opens into segment xi; the clitellum occupies segments x–xiii; the egg-sacs are very large, and occupy about three segments. In these points *Moniligaster* approaches

* Zool. Anzeig., xiii. (1890) pp. 368–72.
† Proc. Roy. Soc. Edinb., xvii. (1890) pp. 5–7.

various limicoline genera. In the species described the more novel points are the small size of the prostomium, which does not extend on to the peristomial segment; the setæ are like those of earthworms; there are dorsal pores; the mesenteries between the several segments from v–ix are very much thickened; the hearts are in segments vi–xiv, and are of large size; the nephridia commence in segment v, and each has a saccular diverticulum. These and other points seem sufficient to render it necessary to regard *Moniligaster* as the type of a distinct family, equal to the Terricolæ, Lumbriculidæ, &c.

Diachæta Windlei.*—Mr. F. E. Beddard gives an account of the structure of this earthworm, which he compares with *D. Thomasii* and *Urochæta*. The setæ are remarkable for being highly specialized, for while some are simple *f*-shaped, others are ornamented as in Urochæta, and others are large and hooked. There are no epiderm glands between the setæ. The anterior pair of nephridia form a "mucous gland," which is not branched, and opens on segment iv. The orifices of the nephridia are guarded by a sphincter. There are no posterior glands connected with the nephridia, and no calciferous glands; as to the latter character, however, it is to be noted that part of the intestine (segment xii–xiv) has a similar structure.

Phreoryctes.†—Mr. F. E. Beddard has a memoir on the anatomy, histology, and affinities of this form. Among the more important or novel points we may note the absence of genital or penial setæ, and the position of the clitellum from the tenth to the thirteenth segments; the epidermis of this region is formed by a single layer of glandular cells which differ from the cells of the general body surface by their glandular character and greater length; the nephridia commence in the sexually mature worm in the sixteenth segment; both series of genital ducts have the distal region lined with a chitinous membrane, which, perhaps, indicates their origin from an ectodermic invagination; the developing spermatozoa are contained in sperm-sacs which occupy segments nine to fourteen; the ova, which, when mature, are of very large size, undergo their development in egg-sacs.

These and other characters justify the formation of a distinct family for this genus; as to its systematic position it is observed that in the character of its generative organs it stands midway between earthworms and the majority of the forms that have been grouped together as Limicolæ; so, too, in other points it has retained some of the characteristics of earthworms, while in other respects it has acquired the simpler structure of the aquatic Oligochæta. It can neither be placed with the "Limicolæ" nor the "Terricolæ," and it makes such a division of the Oligochæta impossible.

Russian Earthworms.‡—Mr. N. Kulagin makes some additions to his previous observations on the anatomy of Russian earthworms. Club-shaped glands are alone found in the hypodermis of *Lumbricus terrestris*; the apparent difference in the glands to which Uhde has drawn attention is due to whether the glands do or do not contain secretions. The cell-

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 159–74 (1 pl.).
† Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 629–40 (1 pl.).
‡ Zool. Anzeig., xiii. (1890) pp. 404–6.

aggregates observed by Uhde in the setigerous regions of segments 9–11, 26 and 29 are connected with nerves which arise from the abdominal ganglia. In *Allolobophora fœtida* the glands of the clitellum are sometimes not confined to the hypodermal layer, but traverse the circular and longitudinal layers of muscles. The innermost, third, layer of the membrane of the nervous system is connective and not cuticular. The subœsophageal ganglion of *Lumbricus terrestris* gives off eight pairs of nerves, and not seven, as stated by Friedländer. The contents of the nerve-canals consist of fibres which are imbedded in a plasmatic mass. The author's account of the histology of the stomach does not agree with that of Claparède; he finds the gastric cavity lined by epithelial cells, above which there is a layer of cells, which in form resemble those of the cœlom; they are succeeded by the circular and longitudinal layers of muscles. On the abdominal surface the circular muscles run parallel to the abdominal wall of the stomach, while at the sides they are directed obliquely to the axis of the body; the fibrils of the circular muscles are longitudinally striated, and in isolated filaments nuclei may sometimes be found. The longitudinal muscles are in the form of special bands which vary in form in cross section.

In the region of the typhlosole and the cylindrical cells which line the enteric cavity cells are sometimes found which, in form, closely resemble those of the cœlom; similar cells are also found in the muscular layers of the enteron; all intermediate stages are found between these and the chloragogen cells. The various statements which have been made as to the number of heart-like vascular loops in various species of earthworms are probably due to the age of the worm and the time of year when the investigation was made; in winter these loops are narrower in diameter than they are in summer. Every heart has not the form of a string of pearls, but of a curved tube narrowed at either end, where it opens into the dorsal and abdominal vessels.

Development of Germinal Layers of Tubicolous Gephyrea.*—M. L. Roule has studied at Cette the development of the germinal layers of *Phoronis Sabatieri*. The fertilized egg undergoes very regular segmentation; the young morula, composed of thirty-two blastomeres, has no central cavity, and the divisions of the cells are effected in all directions. Most, however, are radial in direction and a blastocœl appears which gradually increases in size. The young spherical blastula takes on an oval and then a discoidal form. When it becomes a disc flattened on each surface it becomes depressed in the centre. The blastopore of this gastrula soon becomes excentric in position, and the body becomes divided into a preoral and a postoral portion.

In the narrow blastocœl there may soon be seen a few thick cells which arise from the meso-endoblast and form a primary mesenchym. Later on, the archenteron becomes pierced by a second orifice which forms the anus of the *Actinotrocha*, while the blastopore becomes the mouth. The ectoblastic cells at the tip of the preoral region elongate considerably and so produce a small cephalic plate. The initial mesoblast-cells segment and give rise to some mesenchymatous cells which form the mesoblastic stripes.

* Comptes Rendus, cx. (1890) pp. 1147–9.

On the whole, the development of the germinal layers in *Phoronis* recalls that which one is in the habit of finding in the *Trochophora*-type; the presence of more than two primitive mesoblast-cells is a sign of inferiority, and suggests that their presence in the Trochozoa is a simplification of a primitive plurality such as is found in the larvæ of some Platyhelminths.

β. Nemathelminthes.

Histology of Ascaris.*—M. L. Jammes states that he has searched in vain, in *Ascaris megalocephala*, *A. lumbricoides* and *A. suilla* for the epithelial layer formed of very small cells which Leuckart thinks lies against the muscle-cells. The so-called granular layer has been found to be continuous, and identical in structure, with the œsophageal nerve-ring; both are formed of fibrils mingled with cells. Sections taken along the body show, in this granular layer, small beds of cells which are often arranged in several rows, but never form a continuous epithelium. These cells are rarely cubical, sometimes rounded, often flattened parallel to the wall of the body, and have a varying number of prolongations. No intercellular substance was ever found.

The great resemblance in structure between the granular layer and the nervous system allows us to suppose that the former represents the ectoderm; this would differ much from the ectoderm of other Metazoa, in being formed of neuro-epithelial elements. If this be so the nervous system described by various authors would be merely a condensation of this layer in different parts of the body. The author is testing this hypothesis by embryological researches.

γ. Platyhelminthes.

Anatomy and Histology of Nemertines.†—Dr. O. Burger has given considerable attention to the structure and systematic relations of the Nemertinea. They all have a ciliated cylindrical epithelium which either contains the whole of the glandular mass of the skin, in which cases it rests upon an almost structureless layer of connective tissue, or some of the gland-cells sink into the layer of connective-tissue, where a cutis is formed, which is often rich in muscles. The appearance of this cutis leads to some considerable changes—the appearance of an external layer of longitudinal muscles, of subepithelial muscular layers, and the formation of a muscular tissue at the cephalic extremity. The Enopla are characterized by a cephalic gland. In all groups there is found the radial musculature, the bands of which divide into chambers the muscular layers of the dermo-muscular tube. By the presence of a ciliated epithelium and numerous gland-cells, the integument of the Nemertines exhibits a distinct resemblance to that of the Turbellaria. The Annelids as a rule have no cutis, but such a layer has been described by Andreæ in *Sipunculus nudus*. In both Annelids and Nemertines the naked gland-cells of the skin become greatly swollen at the time of sexual maturity, and the dermo-muscular tube of Annelids resembles that of many Nemertines in that it consists of a circular and a longitudinal

* Comptes Rendus, cxi. (1890) pp. 65–6.
† Zeitschr. f. Wiss. Zool., li. (1890) pp. 1–277 (10 pls.).

muscular layer. In all Nemertines a parenchyme is greatly developed and the organs are imbedded in a gelatinous tissue; in many this tissue is, in the region of the mid-gut, divided into dissepiments. In some there is a cleft which Salensky has compared to a cœlom. Though the Turbellaria have no spaces between the body-tissue and gut, there are muscular septa which are specially noticeable in the elongated *Gunda segmentata*; on the other hand the marked metamerism of the dissepiments of the Nemertinea lead us to the Annelids, and especially to the Hirudinea.

In the digestive apparatus of the Nemertinea there are two regions distinguished both histologically and morphologically; the intestine is on the type of that of Annelids, while that of Turbellarians is aproctous. The characteristic cavity of the proboscis—or rhynchocœlom—is not to be compared with any structure in the Turbellaria. As to the Annelids the author suggests that, while in them the organs lie in a cœlom, only a limited cœlom is developed in the Nemertinea in which the proboscis and part of the dorsal vessel lie—this is the rhynchocœlom, and the free bodies which are to be found in it may be compared with the bodies of the perivisceral fluid. The body of the more highly organized Nemertinea contains two cavities which one may regard as a cœlom, but it is not to be supposed that these cavities are of equal value. The cleft between parenchyme and intestine appears, from its cellular investment which is very similar to that of the genital sacs, to be in all probability a schizocœl. The rhynchocœlom, on the other hand, represents the remains of the primitive cleavage-cavity. Whether or not either of these spaces is the homologue of the cœlom of Annelids, embryological investigations will have to determine.

The Nemertinea have, but the Turbellaria have not, a blood-vascular system. The similarity of the excretory systems of the two groups is undoubted, especially if the ends of the excretory vessels in Nemertines are, as in *Tetrastemma aquarum dulcium*, provided with ciliated lobules. At the same time, a comparison with the same system in Annelids is not excluded, for we have only to call to mind *Lanice conchilega* where four nephridia on either side are connected by a longitudinal canal.

The nervous system of Nemertines passes, as is well known, through a number of stages. On the whole, it exhibits a very large number of points of resemblance to that of Annelids, while its points of agreement with that of the Turbellaria are much more general; on the other hand, the Nemertine eye may be briefly characterized as a Turbellarian eye.

The extraordinarily complicated generative apparatus of the Turbellaria finds no parallel in Nemertines, and we must come to the conclusion that while the latter are derived from forms like the Turbellaria they branched off along the Annelid stock and again diverged to take up an independent line of their own.

The author describes a number of new species belonging to *Cerebratulus*, *Eupolia*, and other genera, and a new genus of the Enopla; this last, which he calls *Prosadenoporus*, is distinguished from all four-eyed aquatic genera by its large cephalic gland, the confluence of mouth and proboscis-orifice, and the complete hermaphroditism of its species.

δ. Incertæ Sedis.

Philodina macrostyla and Rotifer citrinus.*—Mr. G. Western has some notes on these two Rotifers, found in a bog pool on Wimbledon Common. *R. citrinus* does not seem to have been found, at any rate, in England since Ehrenberg's time, and certainly differs from any described in the monograph of Dr. Hudson and Mr. Gosse; the latter author was probably wrong in regarding *R. citrinus* as synonymous with *R. tardus.*

Echinodermata.

Echinodermata.†—Prof. H. Ludwig concludes his account of the Cuvierian organs of Holothurians, and next deals with the generative organs. External sexual differences are very rare, but the males of *Thyone aurantiaca*, *Cucumaria lævigata*, and *C. elongata* have a genital papilla, while the females of *Cucumaria crocea* and some other species have a kind of brood-pouch.

The blood-vascular system is next described; the vessels are distinguished by two anatomical peculiarities—a tendency to form plexuses, and the absence of an internal epithelium; in some, but not in all cases, calcareous corpuscles are to be found in their connective tissue. Radial blood-vessels may be said to be certainly present in the Aspido- and Dendrochirota, but it is not certain that they are present in the Synaptidæ. The ciliated organs of the Synaptidæ are next described; they are found in numbers, connected with the mesenteries, and occasionally also on the body-wall. The cœlom forms the subject of the fourteenth chapter; its secondary spaces are arranged under the heads of pharyngeal and subpharyngeal sinus, genital sinus, pseudhæmal and epineural canals; the connection of the cœlom with other cavities of the body or with the outer world, the lining of the cœlom and its fluid contents, form the remaining subjects dealt with in this part of Professor Ludwig's work.

Anatomical Nomenclature of Echinoderms.‡—Dr. P. Herbert Carpenter makes a plea for greater uniformity of nomenclature in the parts of Echinoderms. He suggests that the term water-tube should be used only to denote the madreporic or stone-canal; he falls foul of various writers who have confused the dorso-central of the Echinoid with the centro-dorsal of the Crinoid. As the nomenclature of the plates forming the dicyclic base in many Crinoids is still wanting in uniformity and precision, he proposed an amended nomenclature; the changes will be best seen by the following table:—

Nomenclature of J. Muller ..	Basals	Parabasals	First Radials	Second Radials	Third Radials
Nomenclature of Carpenter and de Loriol ..	Underbasals	Basals	„	„	„
Nomenclature now proposed	Infrabasals	Basals	Radials	First Costals	Second Costals

* Journ. Quek. Micr. Club, iv. (1890) pp. 87–91 (1 pl.).
† Bronn's Klassen u. Ordnungen, II. 3, Echinodermata, pp. 177–240 (pls. ix.–xii.).
‡ Ann. and Mag. Nat. Hist., vi. (1890) pp. 1–23.

Function of Madreporic Plate and Stone-canal of Echinodermata.* —Prof. H. Ludwig altogether denies the accuracy of Prof. M. Hartog's observation that the direction of the current is from within outwards in the pore canaliculi of the madreporic plate and in the interior of the stone-canal. Prof. Ludwig took the opportunity of a visit to Naples to investigate the point in *Holothuria tubulosa*, *Stichopus regalis*, *Sphærechinus granularis*, *Asterina gibbosa* and *A. Pancerii*, *Antedon rosacea*, and some Auricularíæ. In all cases he found the direction of the stream to be from without inwards, and he gives details of his observations in support of his generalization.

M. L. Cuénot † answers Prof. Hartog's note of reclamation,‡ and gives reasons for not noticing his work, and then proceeds to raise certain objections to Prof. Hartog's view as to the nephridial function of the madreporic system.

Function of Gemmiform Pedicellariæ of Echinoids.§ — M. H. Prouho contributes a very interesting observation to the very vexed question of the functions of pedicellariæ. If a specimen of *Strongylocentrotus lividus* or *Sphærechinus granularis* be placed in a vessel in which there are one or more specimens of *Asterias glacialis* which have been compelled to fast for some time, the Echinoid will be immediately attacked by the starfishes. As soon as it feels the touch of their ambulacral tubes it rapidly withdraws its spines from the part threatened; the spines bend out from the centre of attack to so great an angle that they become almost tangential to the test. In thus removing its spines the urchin unmasks its gemmiform pedicellariæ, which are then stretched towards the arms of the starfish with the jaws widely open. The starfish continues its attack, but as soon as one of the pedicellariæ touch an ambulacral tube it immediately bites it; we may suppose that the pain produced is considerable, for the arm of the starfish is actively withdrawn; but it always carries with it the offending pedicellaria fixed in the wound.

In some cases the first bites are sufficient to drive off the starfish, but in others it prolongs its attack, and then it is very interesting to see the urchin unmask its pedicellariæ on the points attacked, and, so to speak, follow the movements of its enemy by showing its teeth. In a first fight the victory is always with the urchin, and the starfish retires covered with wounds. But, as each pedicellaria serves only once for the defence of the urchin, it is gradually deprived of its organs for this purpose. If an urchin is put with several starfishes and abandoned to its fate it succumbs at last.

The moment an Echinoid is warned by its peripheral nervous system of the danger which threatens it, it moves its spines in a way which has nothing in common with the ordinary movements of these organs, and which has no other object than to unmask its gemmiform pedicellariæ. It is of interest to observe that this movement is exactly the opposite of that which is produced when the surface of the test is wounded by, for example, the point of a needle; in that case the spines and pedicellariæ are inclined towards the wounded point.

* Zool. Anzeig., xiii. (1890) pp. 377–9.
† T. c., pp. 315–8.
‡ See this Journal, *ante*, p. 337.
§ Comptes Rendus, cxi. (1890) pp. 62–4.

Rhynchopygus woodi.*—Mr. J. W. Gregory brings forward evidence to show that the problematic form called by E. Forbes *Echinarachnius woodi* belongs to the genus *Rhynchopygus;* this settles the question raised by Prof. Alex. Agassiz that it was probable that we had here to do with a fossil Pourtalesiid.

Sense of Smell in Starfishes.†—M. Prouho has made a number of experiments with *Asterias glacialis.* Some of these have shown him that when a starfish is excited by a desire for food, the sensations which it obeys are perceived by the extremity of the arms; but others show that it is the sense of smell and not of sight that guides it to its food. The "palps" or tentacles near the eye-like spot, which are useless for locomotion, were removed from a starfish, which, for a month or more afterwards, never showed the least excitement in the presence of either living or dead food; the retention of the ocular spot makes no difference. It is clear, then, that the sense of smell is not diffused in Starfishes, but is localized in the ambulacral tubes which are unsuitable for locomotion and are situated behind the eye-spot. If the ambulacral nerves are cut through at about 2 cm. from the extremity in such a way as to isolate in each a small distal portion, provided only with a small number of ambulacral tubes, these last become distended in the presence of food, but the excitement ceases at the level of the section.

Cœlenterata.

Actiniæ of South-west Coast of Ireland.‡—Prof. A. C. Haddon has a short notice of some species of Actiniæ from the deep water off the south-west coast of Ireland. *Actinan[u]ge* sp., *A. richardi*, *Chitonactis* sp., *C. coronata*, *Sagartia* sp., *S. miniata*, *Adamsia palliata*, *Bolocera tuediæ*, and *Actinerus* sp. are recorded.

Morphology of Skeleton of Stony Corals.§—Dr. A. Ortmann discusses the morphology of the skeleton of Stony Corals in relation to the formation of colonies. He points out that the simplest form of a Stony Coral arises in the following manner:—A coral-person, at first without a skeleton, but with enteric cavity, pharynx, and mesenterial folds, becomes fixed. The parts in contact with the substratum give out a cuticular calcareous excretion, by which the foot-plate (basal plate of v. Koch) is formed. From the base of the coral radially arranged folds are formed between the mesenterial folds, and their ectodermal elements (chalicoblasts) secrete the calcareous septa. The skeleton consists, therefore, of the basal plate lying on the substratum and the septa (radial plates of v. Koch) which rise up from it. No recent coral exhibits this primitive form of skeleton, but it is often found in the young buds of coral colonies; the primitive form is always complicated by certain characters. The further developments of the skeleton not connected with the formation of colonies may be grouped thus:—(*a*) The septa become connected by epitheca; (*b*) or by a wall; (*c*) or fuse laterally to a varying extent. The further developments of the skeleton which are

* Geol. Mag., vii. (1890) pp. 300–3 (1 fig.).
† Comptes Rendus, cx. (1890) pp. 1343–6.
‡ Proc. Roy. Irish Acad., i. (1890) pp. 370–4.
§ Zeitschr. f. Wiss. Zool., l. (1890) pp. 278–316 (1 pl.).

connected with colonial formation may be prolate or acrogenous growths, or both.

The colonial formation of stony corals is brought about by a number of processes of budding, each of which causes a certain characteristic growth; the different forms may be grouped under certain heads. The simple young form may produce new persons in two ways—either by internal or by external budding. In the former process the calycinal cavities of the body and of the maternal calyx are directly connected, while they are not so in the latter; the two modes of budding pass into one another.

The following arrangement of the various processes is proposed:—

A. Internal Budding. The budding is effected within the wall of the simple young polyp, and the calycinal cavities of the buds are directly connected with those of the maternal calyx.

1. Partial Budding. The wall of the young is almost cylindrical. The buds are formed by a constriction of a part of the maternal calyx. (Partial + Septal Budding of v. Koch.)
2. Cœnenchym-Budding. The wall of the young is broadened out. The septa form a cœnenchym in which new calycinal centres, which are not constricted, are formed. (Partly v. Koch's Cœnenchym-Budding.)

B. External Budding. The budding is effected outside the wall of the simple young polyp, and the calycinal cavities of the buds are not directly connected with those of the maternal calyx.

3. Wall-Budding. The buds are placed directly on the wall of the maternal calyx.
4. Costal-Budding. The buds are set on the costæ, which are developed outside the wall. (Typical Cœnenchym-Budding of v. Koch.)
5. Stolon-Budding. The buds lie at some distance from the maternal calyx, and are at first connected with the latter by stolons. (Stolon-Budding of v. Koch.)

If the soft parts and not the skeleton are considered, the same classification is arrived at.

Well-marked partial budding is only possible when there is acrogenous growth, by which dichotomously branched trunks are formed (*Mussa*). Cœnenchym-budding is connected with prolate growth, and gives rise to flat lamellæ (*Phyllastræa*). Wall-budding, in its typical form, gives rise to upright trunks, the branches of which are formed by a calyx (*Cyathohelia*). Costal budding gives flattened astræoid colonies, and is always associated with acrogenous growth. Stolon-budding causes basal enlargements, from which the several calyces rise up.

In most cases, however, the several processes of budding are not developed typically. It very often happens that such as require prolate growth are also connected with acrogenous growth so that curved broad colonies are formed, the surface of which may be branched. The several processes of budding are extremely characteristic of forms and even whole groups, for it is very seldom that, as in *Leptastræa*, different modes of budding obtain in one species.

The author regards Prof. Duncan's recent classification as quite

artificial, and attempts another, the chief points of which are here indicated :—

ZOANTHARIA MADREPORARIA.

I. Order: Athecalia.

No circular fold arises from the base of the coral to give rise to a true wall.

1. Suborder: Inexpleta.

    Septa either placed simply on the basal plate or only connected by epitheca. Interseptal chambers empty, no synapticulæ. No acrogenous growth. *Cylicia.*

2. Suborder: Synapticulata.

    Septa connected by synapticulæ which may unite to form wall-like structures, &c.

    a. Simple forms, no prolate growth. *Stephanophyllia.*

    b. Internal budding; prolate or prolate and acrogenous growth.
    Thamnastræidæ, Lophoseridæ, Poritidæ, Fungiidæ.

    c. Simple form with acrogenous growth and secondary wall-thickening, or colonies formed by wall-budding. Secondary thickening of porous wall constant.
    Eupsammiidæ (with *Balanophyllia* and *Heteropsammia*), *Madreporidæ.*

3. Suborder: Pseudothecalia.

    Septa connected by lateral fusion to form a false wall.

    a. Simple form. *Caryophyllia, Desmophyllum.*

    b. Colonies formed by division. *Mussidæ* (fam. nov.).

    c. Colonies formed by external budding.
    Cladocora and *Cyathohelia* : *Heliastræidæ* (fam. nov.).

II. Order: Euthecalia.

A circular fold rises up from the base of the coral and secretes a true wall.

a. Simple forms; acrogenous growth not considerable.
Deltocyathus, Paracyathus.

b. Colonies formed by internal (cœnenchym) budding; marked prolate growth. *Echinoporidæ.*

c. Colonies formed by division; marked acrogenous growth.
Eusmiliidæ (fam. nov.) and *Euphylliidæ* (fam. nov.)

d. Colonies formed by wall-budding; growth chiefly acrogenous.
Amphihelia, Acrohelia, Galaxea.

Porifera.

Freshwater Sponges of Canada and Newfoundland.*—Mr. A. H. Mackay gives a brief outline account of the Spongillidæ of Canada. Ten species belonging to three genera have as yet been recorded.

* Trans. Roy. Soc. Canada, Section iv. (1889) pp. 85–95 (1 pl.).

Protozoa.

Ophrydium versatile and its Zoochlorellæ.*—M. P. A. Dangeard has studied the structure of this Infusorian and of its coloured guests. The cyst recalls that of the *Vorticellæ;* the ectocyst disappears under the influence of concentrated potash, sulphuric, chromic, or nitric acids; the endocyst resists the prolonged action of these reagents. The macronucleus, which in ordinary individuals has the form of a greatly elongated cord, becomes spherical in the cysts; similar observations were made by Stein in *Epistylis branchiophila* and by Entz in *Actinobolus radians.* The author has no doubt that the Zoochlorellæ are true individuals; they are Algæ, belonging to the Protococcaceæ, which live in the interior of their host; they are most nearly similar in organization, development, and size to *Palmella hyalina.* We know but little as to the part which they play. If they are symbiotic the Infusorian profits little by their presence. M. Dangeard suggests that they secrete a gelatinous matter which is utilized by the Infusorian in producing the gelatinous masses which *Ophrydium* is known to form.

Observations on Acinetina.†—The same author gives us the results of his studies of *Podophrya fixa*, *Metacineta mystacina*, and *Trichophrya angulata* sp. n. In the last he has observed a mode of nutrition which is very similar to that of Rhizopoda. Although several authors have described a considerable enlargement of the tentacles for the ingestion of food, none have yet demonstrated the direct entrance of food without the intermediation of the tentacles; that it should happen in this species is, no doubt, due to the great plasticity of its body, the contours of which are easily modified, and to the absence of a solid membrane.

Notes on Flagellata.‡—In another communication M. P. A. Dangeard speaks of the homology of flagella with pseudopodia, which is not freely admitted by some authors. From some observations which he has made on a *Cercomonas*, he concludes that the flagella are only condensed protoplasm, and that they may be formed directly by the transformation of pseudopodia, while, inversely, a flagellum may become a pseudopodium. He thinks that the affinities of the true Flagellata are with the Amœbæ.

Loxodes.§—Prof. E. G. Balbiani gives a detailed account of this Ciliate, the affinities of which have been so much disputed. As the author's historical account shows, many distinguished observers have busied themselves with this form. *Loxodes rostrum* exhibits considerable variability in size, and the figures given by Wrzesniowski apply best to larger examples. There are also differences in coloration, the smallest being perfectly colourless. Conjugation has not yet been observed, and the author brings his detailed account to an end without offering any general conclusions as to the results of his investigation.

Cryptomonadinæ and Euglenæ.‖—M. P. A. Dangeard continues ¶ his studies on these questionable Protozoa, which he somewhat positively

* Le Botaniste (2) i. (1890) pp. 1–14 (1 pl. and 2 figs.).
† T. c., pp. 14–29 (12 figs.). ‡ T. c., pp. 27–33 (2 figs.).
§ Ann. de Micrographie, ii. (1890) pp. 401–31 (1 pl.).
‖ Le Botaniste, i. (1889) pp. 1–38 (1 pl.).
¶ See this Journal, 1888, pp. 754–5.

regards as Algæ, mainly on account of their exclusively holophytic nutrition. He describes species of *Cryptomonas*, *Euglena*, *Phacus*, and *Trachelomonas*, and sums up the general characters of the two families Cryptomonadinæ and Euglenæ. Distinguishing three phases of life—nutritive, reproductive, and conservative, he maintains that those who support the Protozoic character of the above forms have restricted their attention too much to the active stages. Yet in reproduction as well as in nutrition, Dangeard believes that *Cryptomonas*, *Euglena*, &c., are emphatically nearer to Algæ than to Infusorians. Moreover, he concludes that all animals which contain "chlorophyll" owe this (except in two species of *Vorticella*) to the presence of symbiotic Algæ, and thus finds in the chlorophyll of the dubious forms under discussion another argument in favour of their Protophyte character.

Monadina and Chytridiaceæ Parasitic on Algæ.*—M. C. de Bruyne presents the results of his study of the Protozoic parasites on Algæ from the Gulf of Naples. To guard against the error of confounding the parasites with the reproductive cells of the Algæ, he studied the life-histories, and observed the process of parasitism and the impoverishment of the seaweed. His list of Monadina includes *Pseudospora benedeni*, *Ps. edax*, *Gymnococcus cladophoræ*, *G. gomphonemarum*, *G. licmophoræ*, *Aphelidium lacerans*, *Leptophrys villosa*, *Vampyrella incolor*, all new species, and *Ectobiella plateaui* g. et sp. n.; while of Chytridiaceæ he describes *Olpidium bryopsidis*, also a new species.

In his general notes he emphasizes the following facts:—All the forms which he observed carefully were nucleated; *Ectobiella* absorbs materials which have been digested on its surface; though the different species have their favourite hosts, it is possible to transplant them to others. He contends that cilia are modified pseudopodia, connected with the latter by intermediate forms, and capable of being retracted and remade.

Coccidia of Stickleback and Sardine.†—M. P. Thélohan describes two new species of Coccidium—*C. gasterostei* and *C. sardinæ*. The former lives in the cells of the liver, where it undergoes the whole of its development. An encysted form segments and gives rise to four small nucleated spheres or sporoblasts; the nucleus of each divides and the binucleated sporoblasts elongate, become surrounded by an envelope, and take on the typical appearance of a spore containing two nucleated falciform bodies. *C. sardinæ* was found in the testes of sardines, and is a good deal larger (50 μ) than *C. gasterostei*; the adult only was examined; it is remarkable for the small amount of space in the cyst which is occupied by the granular mass and the spores.

* Arch. de Biol., x. (1890) pp. 43–104 (3 pls.).
† Comptes Rendus, cx. (1890) pp. 1214–6.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.

(1) Cell-structure and Protoplasm.

Morphology and Physiology of the Cell.*—Dr. A. Zimmermann has investigated the structure of the chromatophores and differentiations of the cytoplasm in the vegetable cell, with the aid of the methods of fixing and staining employed by Altmann † in the case of animal cells. The following are his most important results.

In various Commelynaceæ the leucoplasts were found to inclose small spherical bodies, apparently consisting of albuminoids, for which he proposes the term *leucosomes*. They were observed in the epidermal cells up to those of the youngest leaf, and were found to differ from those of the future assimilating tissue. Similar leucoplasts containing leucosomes were also found in the mechanical cells, and in certain elements of the vascular bundles. They are distinguished by the fact that at no period of their existence do they contain starch, the formation of this substance usually beginning in the immediately adjacent tissue. Those of the epiderm appear to be quite unable to form starch out of sugar transported to them.

No destruction of the chromatophores takes place in those parts which exhibit etiolation from the want of iron; but the chromatophores are usually considerably smaller and of lighter colour than the chloroplasts of normally green leaves. They could only be detected with certainty by the use of very good objectives and of the best methods of staining. They also appear to be incapable of forming starch.

Altmann's stainable "granules" were found in the assimilating tissue, bodies consisting apparently of proteids, and very widely distributed. In *Tradescantia albiflora* it appears probable that they are connected with the nitrogenous nutrition. Except in young leaves of *Polypodium ireoides*, they had always a more or less spherical form.

By the aid of the method of staining described in detail, the occurrence of protein-crystalloids was detected in the vegetative organs of many ferns. In *Polypodium ireoides* the crystalloids in the epiderm lie not in the cytoplasm, but in the cell-sap. In some ferns the author was able to follow the development of the crystalloids of the nucleus, and found that they result from the coalescence of smaller granules or of vacuoles filled with albuminoids. Similar crystalloids were detected also in some flowering plants, e.g. *Hippuris vulgaris* and various Campanulaceæ and Scrophulariaceæ. They were found chiefly in the epiderm, and, except in *Platycodon grandiflorum*, always within the nucleus. In some cases they are subsequently absorbed, and their constituents probably used up again in metastasis.

* Beitr. z. Morphol. u. Physiol. d. Pflanzenzelle, Heft 1, 79 pp. and 2 pls., Tübingen, 1890. Cf. this Journal, 1888, p. 442.

† Cf. this Journal, 1888, p. 146.

Processes of Growth in the Vegetable Cell.*—Herr J. Behrens has investigated the phenomena connected with the formation of so-called cellulose-folds, chiefly in certain species of *Spirogyra*, and in the assimilating cells of *Pinus*. In *Spirogyra Weberi* the splitting up of the nucleus into two is readily followed. The earlier processes resemble those of direct division; but fixed preparations show that the entire process of nuclear division is the ordinary one of karyokinesis. The space between the combined threads of the daughter-nuclei is a vacuole. In this, as in other examples which are described (epidermal cells of *Tradescantia*, &c.), no entrance of cytoplasm into the nucleus could be detected. The vacuole between the nuclei in *Spirogyra* is not formed by the enlargement of one previously in existence, but is altogether freshly formed; ultimately it entirely disappears.

The peculiar formations on the septa of *Spirogyra Weberi* have been hitherto regarded as folds; but the author confirms the statement of Strasburger that they are thickening-bands; they grow by apposition at their margin, like the septa themselves. The similar folds in the cell-walls of the assimilating tissue in the leaves of *Pinus sylvestris* can also, according to the observations of the author, be explained on the theory of apposition, though it is not impossible that intussusception may also contribute to their growth. The processes appear to be similar in the folds of the cell-wall in the mesophyll of *Calamagrostis epigejos*, and in those of the shields of the antherid of *Chara fœtida*.

Commenting on this paper, Herr G. Haberlandt † points out that his views on the position of the nucleus in mature cells,‡ which Behrens has criticized unfavourably, refer simply to the fact that the nucleus does take up a definite position in such cells, and do not touch the question whether this is brought about by an active motion in the nucleus itself, or whether it is carried passively by currents in the protoplasm.

Reactions of Cytoplasm.§—From experiments on the leaves of a specimen of *Echeveria*, Herr T. Bokorny finds that a 1 per cent. solution of caffein causes aggregation of the cytoplasm and formation of proteosomes without killing the protoplasm. From the fact that there is frequently a very great abundance of both protoplasm and tannin in the same cell, he infers a close connection between these two substances.

Quantitative Estimate of Cellulose.‖—By the use of Hoppe-Seyler's method, Herr G. Lange has determined the proportion of cellulose in various woods and in turf to vary from 44 per cent. in the latter to 55 per cent. in oak-wood.

Alkalinity of Protoplasm.¶—Herr A. Meyer contests the statement of Schwarz** that the protoplasm in the living cell has generally an alkaline reaction. He affirms that this reaction is frequently the result of the treatment to which the protoplasm has been subjected in making the experiments; and, moreover, that the so-called alkaline reaction of

* Bot. Ztg., xlviii. (1890) pp. 81–8, 97–101, 113–7, 129–34, 145–50.
† T. c., pp. 221–2. ‡ Cf. this Journal, 1887, p. 980.
§ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 101–12 (1 pl.).
‖ Zeitschr. f. Physiol. Chemie, xiv. pp. 283–9. See Bot. Centralbl., xlii. (1890) p. 307.
¶ Bot. Ztg., xlviii. (1890) pp. 234–7. ** Cf. this Journal, 1887, p. 979.

a substance, i. e. an action on certain pigments similar to that produced by alkalies, is by no means a certain proof that the substance in question contains an alkali, or even possesses basic properties.

(2) Other Cell-contents (including Secretions).

New Green Vegetable Colouring Matter.*—Mr. C. M. Smith describes a green colouring matter obtained from the green bitter pulp of the fruit of *Trichosanthes palmata*. The spectrum of its alcoholic solution differs from that of chlorophyll in its first absorption-band having its centre almost midway between the two chief chlorophyll-bands, while the bands III., IV., and V. are probably coincident with bands of true chlorophyll. Its behaviour with ammonium sulphide entirely differs from that of chlorophyll. This colouring matter appears to be a substance in which the "blue chlorophyll" of Sorby or the "green chlorophyll" of Stokes is replaced by some other substance easily decomposed by reducing agents and acids.

Chromatophores of Bleached Leaves.†—Dr. A. Zimmermann finds well-defined chromatophores to be generally present in albinized parts of plants; they agree with the normal green chloroplasts in form, but are much smaller and of a much lighter colour. Frequently also they are of a vesicular character, from containing one or more vacuoles. But all these modified chromatophores, even the vesicular ones, still retain the power of forming starch, though to a diminished extent.

Proteinaceous bodies in Oncidium.‡—Herr K. Mikosch finds in the cells belonging to the epiderm of both sides of the leaf of *Oncidium microchilum*, from Guatemala, peculiar proteinaceous bodies formed out of the granular protoplasm of the cells, and bearing a strong resemblance to those previously found by Molisch § in *Epiphyllum*. They are annular, fusiform, or loop-shaped, partially or entirely soluble in alcohol, and are coloured bright red by Millon's reagent, pink by a solution of sugar and sulphuric acid. Their occurrence is exceedingly irregular, and nothing could be determined as to their function; they appear to be formed independently of external conditions, sometimes disappearing, and being apparently again re formed. No similar structures were found in other species of *Oncidium* examined.

Tannin and its Functions.‖—Dr. K. Bauer describes in detail the mode of occurrence of tannin in the following plants, chiefly in the leaves, stem, root, and rhizome:—*Iris pseudacorus*, *I. sibirica*, *Marica Northiana*, *Ficus elastica*, *F. australis*, *Cyperus Papyrus*, *Saururus cernuus*. It may occur either in the ordinary cells of the tissue or in specially formed cells, idioblasts. In the former case it is often accompanied by starch or chlorophyll; in the latter case it is always the sole content of the cell.

As to the function of the tannin, it is clear that in many cases,

* Proc. Roy. Soc. Edinburgh, March 17, 1890. See Nature, xli. (1890) p. 573.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 95-7.
‡ T. c., pp. 33-8 (1 pl.).
§ Cf. this Journal, 1886, p. 89.
‖ Oesterr. Bot. Zeitschr., xl. (1890) pp. 53-7, 118-23, 160-3, 188-91. Cf. this Journal, *ante*, p. 53.

especially when stored up in the testa of the seeds, it serves to protect the part against the attacks of animals, and also as an antiseptic agent. The immense quantities in which it is stored up in the rhizome of *Iris pseudacorus* and *sibirica*, and especially in the spots where adventitious roots are about to be formed, appears to indicate that it is, at least in these cases, something more than a mere product of excretion, and is used up again in the process of metastasis.

Anthocyanin.*—Prof. D. Levi-Morenos has investigated the anthocyanin which is the colouring matter of the dark dots on the leaves of certain species of *Sedum*, e. g. *S. album*, especially in the epidermal cells in the neighbourhood of the stomates. The function of this colouring matter appears to be protective, in preventing the too powerful action of the rays of light.

Localization of the Principles of Hydrocyanic Acid.†—M. L. Guignard refers to the production by certain plants of hydrocyanic acid, due to the action of emulsin or synaptase on amygdalin in the presence of water. He now describes the localization of the principles of hydrocyanic acid in the almond and cherry-laurel. Emulsin is found in the almond in the pericycle, and in the vascular bundles of the cotyledons; while in the cherry-laurel, the pericycle being sclerotized, it is found in the endodermal sheath. The presence of emulsin may be determined by Millon's reagent, or by sulphate of copper; with the former a red coloration is obtained, and with the latter a violet.

Distribution of Chemical Substances in Plants.‡—Herr E. Schär gives an exhaustive summary of what is known with regard to the distribution of the various chemical substances in the vegetable kingdom. These he treats under the head of—I. Generally distributed substances, such as the inorganic constituents, carbohydrates, acids, and pigments. II. Specific vegetable substances; the latter being again classified under the following seven heads:—(1) Alkaloids; (2) fatty acids; (3) acids of the aromatic series; (4) phenols, chinones, and ketones (benzol, naphthalen, and anthracen series); (5) essential oils; (6) specific pigments; (7) glucosides (such as digitalin and santalin) and bitter substances. He points out the remarkable fact of the complete absence or great rarity of alkaloids in very large sections of the vegetable kingdom, such as the Vascular Cryptogams, the Gymnosperms, the Monocotyledons, and the orders Compositæ and Labiatæ.

(3) Structure of Tissues.

Transformation of Epiderm.§—Herr E. Heinricher describes a peculiar development of the inner layer of the epiderm of the capsule in *Adlumia cirrhosa* (Fumariaceæ). It becomes converted, as the fruit ripens, into a layer of mechanical fibre-cells, with narrow or transversely oval dots; they broaden out at their apex, and their walls are uniformly

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 79–80.
† Journ. de Bot. (Morot), iv. (1890) pp. 3–12, 21–7 (4 figs.), and Comptes Rendus, cx. (1890) pp. 477–80.
‡ Vierteljahrschr. Naturf. Gesell. Zürich, 1888 (1890) pp. 323–78.
§ SB. Akad. Wiss. Wien, xcix. (1890) 15 pp. and 1 pl. See Bot. Centralbl., xlii. (1890) p. 345.

strongly thickened and lignified; there is no cuticle. The layer of cells thus peculiarly transformed appears to serve the purpose of a reservoir of water for the purpose of assisting in the germination of the seeds which commences within the capsule.

Resin-producing Receptacles.*—Herr A. Tschirch states that purely lysigenous secretion-receptacles are probably rare; in a large number which are ordinarily so termed the cavity is first formed schizogenously, its subsequent development being in a lysigenous manner. The resin or oil is never found in the cavity itself, but in the adjacent epithelial cells, and the formation of these substances must be a purely chemical process, since living protoplasm is never found in them, whether they be of schizogenous or of lysigenous origin. In *Styrax Benzoin* there are no resin-receptacles, the fragrant substance not being a product of the plant in a healthy condition; it flows out copiously from wounds in the stem, and must be regarded as a pathological result of injury.

Gluten-layer in the Endosperm of Grasses.†—Herr G. Haberlandt states that the gluten-layer (Kleberschicht) in the endosperm of rye and other grasses is not, as has been hitherto stated, primarily a tissue for storing up food-materials; nor does it serve merely to conduct the diastase from the scutellum to the growing embryo; the enzyme is actually formed in it. As soon as germination commences, both the pericarp and this layer detach themselves from the rest of the endosperm. A similar phenomenon occurs in buckwheat, and probably also in many other seeds.

Comparative Structure of the Stem of Trees.‡—M. L. Flot divides this paper into two parts; in the first the external morphology is treated of, and in the second the internal morphology of a number of types is carefully described and compared.

In a plant a year old the lower part of the stem differs in structure from either the root or the stem proper, and the author calls this the tigellary region. The distribution of cork affords one of the most interesting morphological differences in the structure of stems. It may appear in five places:—(*a*) In the epiderm (apple). (*b*) In the majority of trees it forms a subepidermal layer of from 1–2 (mountain ash) to 20 layers (*Paulownia*). (*c*) In certain trees (*Robinia*) the separating meristem arises in a deeper stratum, and several sub-epidermal layers are in this way atrophied. (*d*) It can appear in a region deeper than the cortex and near the endoderm (Rosaceæ). (5) In *Clematis*, the vine, &c., it forms in the pericycle.

A *résumé* of the characters of the cortex is then given. The cortex of the cauline region of a plant a year old is similar in structure to that of an old branch; an external zone with thick walls may be distinguished, and an internal zone with thin walls. In the tigellary region all the parenchyme has thin walls.

The general conclusions arrived at are as follows:—(1) In a plant a year old there are two distinct regions: the cauline and the tigellary.

* SB. Gesell. Naturf. Freunde Berlin, 1889, pp. 173–5. Cf. this Journal, 1888, p. 604.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 40–8 (2 figs.).
‡ Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 17–32, 66–77, 122–36 (4 pls. and 32 figs.).

(2) In certain trees the tigellary region only developes during the first year. (3) The tigellary region is a special structure, and is characterized by (*a*) the early appearance of hypodermal, cortical, or pericyclic cork; (*b*) a large development of the external parenchymatous zone; (*c*) absence of differentiation in the external zone of cortex; (*d*) a great reduction or absence of sclerenchyme; (*e*) a large development of wood; (*f*) absence of the parenchymatous circum-medullary zone; (*g*) feeble lignification of the ligneous elements; (*h*) a reduction in the diameter of the pith. (4) From a physiological point of view the terminal shoot of an old tree presents no differences from the caulinary region of a tree a year old; the tigellum is always distinguished by the accumulation of reserve-material.

Stem of Cycadeæ.*—Graf zu Solms-Laubach finds, in the stem of *Stangeria*, a cone of vascular bundles, which is prolonged upwards into a simple cylindrical tube, and the axis of which deviates only slightly from the horizontal. A similar structure probably occurs also in the stems of other Cycadeæ.

Decortication of the Stems of Calycanthaceæ, Melastomaceæ, and Myrtaceæ.†—M. O. Lignier states that the structure of the cork in Melastomaceæ presents various aspects. When it forms in the epiderm it is composed of uniform cells with thin walls. The pericambial cork of the Memecyleæ is formed of uniform sclerotized cells, whereas the cork of the first group of Melastomaceæ (comprising the Microlicieæ, Osbeckieæ, and Rhexieæ) is stratified when it is pericambial. The author confirms many of the observations of M. Douliot,‡ and also points out that the successive layers of cork in the Myrtaceæ present a very regular stratification.

Function of the Sieve-portion of Vascular Bundles.§—Herr J. Blass argues against the prevalent view that the main purpose of the sieve-structures in the phloëm of vascular bundles is for the transport of albuminoids. His main arguments are derived from the fact that sieve-structures do not occur in the part where they would be most required for this purpose, viz. in the immediate vicinity of the growing point, being never found in the uppermost internode; from their very small number in proportion to the number of vessels; and from the circumstance that the sieve-pores are frequently almost entirely closed, or the passage through them of the albuminoids greatly hindered by large accumulations of callus. From an examination of woody and herbaceous plants, Herr Blass found that the development of the sieve-structure bears, as a general rule, a direct proportion to the development of xylem, being, e. g., almost entirely suppressed in aquatic plants; and he believes that its chief function is to supply a store of food-material for the formative cambium, and for the xylem of the vascular bundles, bearing the same relation to these portions of the bundle that the starch-sheath does to the phloëm portion.

* Bot. Ztg., xliii. (1890) pp. 177–87, 193–9, 209–15, 225–30 (1 pl.).
† Bull. Soc. Bot. France, xxxvii. (1890) pp. 12–7.
‡ Cf. this Journal, 1889, p. 406.
§ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 56–60.

Special Elements in Glycine sinensis.*—Dr. B. Pasquale finds in the young branches of this leguminous plant, here and there in the tissue of the pith, soft bast and cortex, special elements of two forms—tubular and isodiametric, the former of which have a temporary, the latter a permanent function. The transitory elements are formed of living, the permanent of dead cells. The isodiametric elements result from the development of single cells, the tubular from the fusion of several. Both kinds appear to serve as reservoirs for substances varying widely in composition, among which are always found proteids, and frequently tannin and sugar. Their chief function appears to be a protecting one.

Constituents of Lignin.†—Herr G. Lange has obtained the same results from pine as from beech and oak-wood, decomposition of the lignin taking place, under the action of alkalies, into cellulose and two different lignic acids. He thinks it probable, however, that in the wood the cellulose is in composition with one lignic acid only.

(4) Structure of Organs.

Monocentric and Polycentric Flowers.‡—Prof. F. Delpino classifies the flowers of Angiosperms under two great series:—*euanthic*, or those which are strictly monothalamic, and *pseudanthic*, which have either polythalamic flowers, or in which the inflorescence perfectly simulates the structure of a simple flower. All Monocotyledons are euanthic, as also are nearly all Corollifloræ and Achlamydeæ, many Monochlamydeæ, and other orders belonging to primitive types, such as the Ranunculaceæ, Papaveraceæ, Aristolochiaceæ, and many others. On the other hand, the Malvaceæ and allied orders, such as the Sterculiaceæ, Tiliaceæ, Geraniaceæ, and Linaceæ, are pseudanthic, as also are many Euphorbiaceæ. To the same series belong also the Rosaceæ and all allied orders, such as the Myrtaceæ, Saxifragaceæ, Rutaceæ, Guttiferæ, Cistaceæ, &c.

Change of Flowers to Tubers.§—Mr. C. A. Barber describes a plant of *Nymphæa Lotus*, which shows great abnormality in the formation of its flowers. While the first formed flower-buds were developing into the normal flowers, a further and very large development of buds took place; and these buds, which were of slow growth, were found to be curiously deformed. The sepals, which appeared as usual, were not followed in due course by petals and stamens, but were found to enfold a number of green leaves, with occasional buds in their axils, separated from one another, and almost concealed from view by a dense mass of long white hairs. This formation of foliage, instead of floral leaves, accompanied as it was by a swelling of the end of the axis of the flower, may be briefly described by saying that tubers were developed in place of flowers. The author then carefully describes the structure of the deformity which he characterizes as a case of chloranthy.

* Malpighia, iii. (1890) pp. 451–67 (1 pl.).
† Zeitschr. f. Physiol. Chem., xiv. pp. 212–27. See Bot. Centralbl., xlii. (1890) p. 308. Cf. this Journal, *ante*, p. 353.
‡ Malpighia, iv. (1890) pp. 479–92 (3 figs.).
§ Ann. of Bot., iv. (1890) pp. 105–15 (1 pl.).

Stamens of Solanaceæ.*—Prof. B. D. Halsted describes a peculiarity in the stamens of Solanaceæ which is quite independent of their variable mode of dehiscence in the different genera. The central portion of the anther is very fleshy, and is termed by the author the "columella"; the pollen-bearing portion being in the form of a very broad horse-shoe, while all between is cellular tissue. The wall inclosing this pollen-layer often separates early from the columella. In *Solanum carolinense* there are two pollen-cavities in each anther lobe. In *S. rostratum* one of the five stamens is three or four times the size of the other four, but the pollen-cavities themselves are no larger.

Development of Ovary and Placenta.†—Herr B. Schäfer has traced out the history of development of the ovary and placenta, especially in *Ailanthus glandulosa*, and in the orders Malvaceæ, Scrophulariaceæ, Solanaceæ, Caryophyllaceæ, Compositæ, Campanulaceæ, and Œnothereæ. A point on which he lays considerable stress is the area of the receptacle consumed in the formation of a carpel. The superior ovary of Angiosperms is the product of the development of the carpels (leaves), the axis, especially in the inferior ovary, serving only as a support to the carpels. The various forms of placenta can always be traced back to a massive development of the margin of the carpels; where the ovules are scattered over the surface of the carpels there is no true placenta. The placentation in inferior corresponds in all respects with that in superior ovaries.

Bracts of the Involucre of Compositæ.‡—M. L. Daniel draws the following conclusions on the structure of these organs:—(1) The structure of the bracts nearly always differs from that of the foliage-leaves. (2) The orientation of the foliage-leaves being but slightly variable the types of structure are few; they are either homogeneous (both surfaces alike), or normally heterogeneous (with palisade-tissue on the upper surface); occasionally one finds the inverted heterogeneous type (with palisade-tissue on the lower surface). (3) The orientation of the sheath is constant. (4) The orientation of the bracts is exceedingly variable. (5) The absence of chlorophyll or the presence of lacunæ on the two surfaces should not prevent the structure being considered homogeneous. (6) A colourless parenchyme with one surface close and the other provided with lacunæ, and a parenchyme of the same form, but with chlorophyll more abundant on one of the surfaces, belong to the heterogeneous type. (7) The heterogeneous parenchyme is not necessarily of a palisade form on the surface most exposed to light.

Stone of Drupes.§—M. A. G. Garcin distinguishes two types of structure in the stone of stone-fruit,—those which are homogeneous, and those which are composed of different kinds of tissue. They may also be classified into the indehiscent, and those which are partially or entirely dehiscent. The former includes true drupes—*Prunus*, *Zizyphus*,

* Bot. Gazette, xv. (1890) pp. 103–6 (1 pl.).
† Flora, lxxiii. (1890) pp. 62–104 (4 pls.).
‡ Ann. Sci. Nat., xi. (1890) pp. 17–119 (6 pls.).
§ 'Contrib. à l'étude des péricarpes charnus. Du noyau des drupes,' Lyon, 1890. See Bot. Centralbl., xlii. (1890) p. 343.

Rhamnus, and those which are provided with a wing, and resemble a samara—*Loxopterygium*, *Botryceras*. The dehiscent drupes may either split through both mesocarp and putamen—*Juglans*, *Caria*, *Aquilaria*, or through the mesocarp only, and then either septicidally, *Clusia*, *Quapoya*, &c., or septifragally—*Balsamea*, *Boswellia*.

When the tissue of the stone is of uniform structure, it may consist either of true sclerenchymatous cells, as in *Vaccinium*, or of tubular cells, as in *Tropæolum pentaphyllum*. The non-homogeneous stone consists of from one to four distinct layers; in the black and red currant there is only a single layer; in *Cratægus* there are three; in the middle one, each cell contains a crystal of calcium oxalate; in the almond there are four layers. The author concludes, from the history of their development, that the mass of sclerenchymatous cells in the pear have been erroneously regarded as a rudimentary or reduced stone.

Cupule of the Beech and Chestnut.*—From an examination both of the normal structure and of abnormal examples, Dr. L. Celakovsky concludes that the cupule of the Fagaceæ or true Cupuliferæ (*Fagus* and *Castanea*) is not strictly homologous to that of the oak. It is, in fact, a compound cupule or cup-shaped sympode, composed of three orders of axes, each of the three orders (in the chestnut) representing a successive generation. The spines are metamorphosed leaves reduced to a few lateral veins. The male inflorescence of the beech must be regarded as a catkin composed of cymes.

Stomates in the Fruit of Iris.†—Mr. J. B. Farmer points out that in the wall of the ovary of *Iris pseudacorus* stomates continued to be formed during the ripening of the fruit; and that cell-division sometimes takes place in their guard-cells. The two guard-cells of the same stomate do not always behave alike; in some cases one, in others both, guard-cells contain two nuclei, but the cell-wall between them has failed to appear; and all stages of transition may be observed until each guard-cell is divided transversely into two cells, each of which contains a nucleus.

Integument of the Seed of Papilionaceæ.‡—Sigg. O. Mattirolo and L. Buscalioni have made a careful investigation of this structure, and especially of the region adjacent to the umbo of the seed, which they divide into three portions—the micropyle, the "chilarium" or hilary lamina, and the two tubercles (tubercoli gemini), the latter filled with a large quantity of tannin.

Absorbing-organs of the Seeds of Scitamineæ.§—Dr. A. Tschirch believes that a more or less well-developed absorbing-organ occurs in the seeds of all the families of Monocotyledons which possess an endosperm or perisperm. In the Zingiberaceæ, e.g. *Elettaria speciosa*, it has an elongated conical form, and remains in the seed after germination. The young seedling is united with the absorbing-organ,

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 128–62 (1 pl.). Cf. this Journal, 1887, p. 613.

† Ann. of Bot., iv. (1890) pp. 174–6 (8 figs.).

‡ Atti R. Accad. Sci. Torino, xxiv. (1889). See Bot. Centralbl., xlii. (1890) p. 21. Cf. this Journal, *ante*, p. 355.

§ SB. K. Preuss. Akad. Wiss. Berlin, vii. (1890) pp. 131–40.

which is surrounded by the endosperm, by a long filiform appendage of the base of the sheath-like cotyledons. In the Cannaceæ it has a similar form; the seed has no endosperm, and the absorbing organ is surrounded by the perisperm. In the Marantaceæ it is long and filiform, and hooked at the apex. In the Musaceæ, e.g. *Musa Ensete*, it is broad and disk-like, resembling the scutellum of grasses. It remains in the seed, increasing greatly in size after germination.

As to the morphological value of the absorbing organ, Herr Tschirch believes that the cotyledon takes a greater or less share in its formation, but that it does not in itself represent the cotyledon. It is remarkable that in seeds which contain no endosperm, a structure occurs with none of the functions of an absorbing organ, but which resembles it greatly from a morphological point of view.

Anatomy of Cotyledons.*—According to Herr P. Kumm, leaf-like cotyledons exhibit a general agreement in structure with foliage-leaves, but are usually somewhat thicker; the mechanical system is less strongly developed, and, except in *Impatiens*, collenchymatous bundles replace the true bast-fibres. The simplest structure occurs in the cotyledons of exalbuminous seeds which remain permanently beneath the soil, as those of *Phaseolus* and *Vicia*. The palisade-parenchyme and epiderm are but feebly developed in the cotyledons of exalbuminous seeds. Stomates are found on all cotyledons which emerge above the surface, either on one side only or more commonly on both sides. Trichomic structures occur but rarely.

Influence of Alpine situations on Leaves.†—According to observations carried on by Herr K. Leist, the chief differences observed in the leaves of Alpine plants, as contrasted with those of lower altitudes, are in their diminished thickness and increased extent of surface. The former depends chiefly on a decreased development of the palisade-tissue. This may result either from the reduction of the number of layers of palisade-cells, or from a decrease in their vertical diameter and corresponding increase in their width, the number of layers remaining the same. The number and size of the intercellular spaces is increased; the spongy parenchyme often becomes somewhat less close. The cuticle is considerably thickened. The causes of these peculiarities appear to be the lower temperature, and the excessive moisture of the ground at the time when the leaves are unfolding.

Knees of Taxodium distichum.‡—Mr. R. H. Lamborn describes the structure of the so-called "knees" in *Taxodium distichum*, the deciduous cypress of the United States, roots which project horizontally from the stem at a considerable distance from the ground, put out branches which descend vertically into the soil, and are frequently provided with knobs or protuberances on the upper side. He concludes that their function is not connected, as has been generally supposed, with the aeration of the tree, but that their purpose is to support it in the situations where it is

* 'Zur Anat. einiger Keimblätter,' 8vo, Breslau, 1889, 38 pp. See Bot. Centralbl., xlii. (1890) p. 163.

† Mittheil. Naturf. Gesell. Bern, 1889. See Bot. Centralbl., xlii. (1890) p. 118.

‡ Amer. Natural., xxiv. (1890) pp. 333–40 (1 pl. and 1 fig.).

generally found, in a very sandy soil which is constantly flooded by water. Their form, and the fact that the knees as well as the lower part of the stem are usually hollow, gives the necessary elasticity to resist the strain of high winds on the enormous weight of the crown of foliage. When the tree grows in dry upland situations it does not produce these knees.

Spines and Emergences of Euryale.*—Prof. G. Arcangeli describes the hairs and spiny protuberances found on the leaves, leaf-stalk, flower-stalk, and calyx of *Euryale ferox*. The latter are of four distinct kinds, two of which may be classed as emergences, springing from the epiderm or hypoderm, the other two as arrested branches or spines. The stellate bodies which are found on the leaves and floral organs contain large deposits of calcium oxalate in their cell-walls, and answer the double purpose of fulfilling a mechanical function and of eliminating excess of calcium oxalate. The author proposes to bestow on them the term *cladosclereids*.

Intumescences.†—By this term Herr P. Sorauer designates those small knot-like excrescences on leaves, usually of a yellow colour, which are the result of an elongation of the cells without any considerable increase in their number. They are a pathological phenomenon, the result of the presence in the tissue of an unusually large quantity of water at the same time that transpiration is strongly checked.

Tuber of Corydalis.‡—According to Herr L. Jost, the tuber of *Corydalis solida* differs essentially in structure from that of *C. cava*, which is an abbreviated rhizome. It consists, at the time of flowering, of three distinct portions: the uppermost portion has the typical structure of a stem, is provided with scale-leaves, and is penetrated by leaf-traces; the lowermost has the structure of a root, and is provided with lateral roots; while the central and largest portion presents, from a morphological and anatomical point of view, an intermediate structure, and is always formed from the cambium of the parent tuber. This description does not apply to the tuber in its earliest condition, which is simply a swelling of the hypocotyl, and is renewed annually. A similar structure is found in all the species belonging to Irmisch's section of the genus "Pes gallinaceus," which includes, besides *C. solida*, *C. fabacea*, *pumila*, *bracteata*, *longifolia*, *angustifolia*, *nudicaulis*, *caucasica*, *laxa*, *densiflora*, and *kolpakowskiana*. As in other species of *Corydalis*, the embryo has only a single well-developed cotyledon.

Production of Fruit without Fertilization.§—Dr. Fritz Müller records several instances of the production of fruit in plants in which access of pollen to the pistil was impossible, viz. in *Cycas revoluta*, and in a species of *Hedyosmum*. In the latter case the seeds were apparently well developed, but dissection showed most of them to be empty.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 266–71.
† Bot. Ztg., xlviii. (1890) pp. 241–52.
‡ T. c., pp. 257–65, 273–82, 289–94 (1 pl.).
§ Biol. Centralbl., x. (1890) pp. 65–6.

β. Physiology.

Frank's Text-book of Physiology.*—Herr A. B. Frank's new Text-book of Vegetable Physiology is divided into three sections: (1) The physical characters and phenomena of the plant; (2) Metastasis; (3) Reproduction; by far the larger portion being devoted to the second, which treats of the Nutrition of Plants through the roots, i. e. the absorption of water and nutrient substances, transpiration, assimilation, &c. The work is illustrated by some excellent new figures.

(1) Reproduction and Germination.

Ornithophilous Flowers.†—Mr. G. F. Scott-Elliot describes the structure of the flowers in *Musa*, *Ravenala madagascariensis*, and *Strelitzia reginæ*, and the part played by birds in their fertilization. In the banana the usual fertilizers, at least in Natal, are sun-birds, although insects appear to assist. The *Ravenala* is proterandrous, and is often visited by sun-birds. The same is the case with *Strelitzia;* the honey-bee and the diptera, which also visit it, appear to take no part in the pollination.

In South Africa the Cinnyridæ or sun-birds are exceedingly good fertilizers, especially *Nectarinia chalybea* and *bicollaris*, and *Promerops caper*. Like bees they, as a rule, visit only one species of flower at a time. Mr. Scott-Elliot believes that the identity of colour (an unusual shade of red) in the majority of ornithophilous flowers, and on the breast of species of *Cinnyris*, is an important element in this pollination. He describes the mode in which a large number of flowers, natives of the Cape of Good Hope, are visited by birds, viz.:—*Melianthus major* and *comosus;* among Leguminosæ, *Schotia speciosa*, *Erythrina caffra*, and *Sutherlandia frutescens; Erica Plunkenetii* and *purpurea; Tecoma capensis*, *Lycium tubulosum*, *Lobostemon montanum;* among Labiatæ, *Leonotis ovata*, *Salvia aurea*, *Sarcocolla squamosa;* among Proteaceæ, *Protea incompta*, *mellifera*, *lepidocarpon*, and *grandiflora*, *Leucospermum conocarpum*, and *Antholyza æthiopica*.

Insects as Fertilizers.‡—Herr E. Loew gives a number of statistical details with regard to the visits of insects to flowers, and the part taken by them in pollination, chiefly in relation to the flora of the Alps and of northern regions; the results are in general in harmony with those of H. Müller. In reference to the phenomenon of pollination, he proposes to classify the flowers into those with honey near the surface, at a moderate depth, and at a great depth; and the visiting insects into allotropous, hemitropous, and eutropous.

Flowers and Insects.§—Mr. C. Robertson continues his observations on the mode of pollination of American flowers, and of the insects by

* 'Lehrbuch d. Pflanzenphysiologie, mit besonderer Berücksichtigung d. Culturpflanzen,' Berlin, 1889, 242 pp. and 52 figs. See Bot. Centralbl., xlii. (1890) p. 210.
† Ann. of Bot., iv. (1890) pp. 259–80 (2 pls.).
‡ Abhandl. Bot. Ver. Prov. Brandenburg, 1889, pp. 1–63. See Biol. Centralbl., x. (1890) p. 12. Cf. this Journal, 1885, p. 990.
§ Bot. Gazette, xiv. (1889) pp. 297–304; xv. (1890) pp. 79–84. Cf. this Journal, 1889, p. 781.

which the pollination is effected. The present instalments refer to species belonging to the natural orders Nymphæaceæ, Cruciferæ, Geraniaceæ, Balsamineæ, Celastraceæ, and Papilionaceæ.

Dichogamy.*—Dr. A. Kerner v. Marilaun describes the various degrees of perfect and imperfect proterandry, and of perfect and imperfect proterogyny in plants, and the part which imperfect dichogamy (proterandry or proterogyny) plays in the production of hybrids in nature.

Conversion of a bisexual into a diœcious Plant.†—M. A. Giard describes the finding of several plants of *Pulicaria dysenterica*, in which all the ligulate were replaced by tubular flowers. By destroying all normal plants in the vicinity, he succeeded in perpetuating this anomalous form from generation to generation for ten years; thus transforming, by artificial selection, a gyno-monœcious into a diœcious Composite.

Strengthening of the Sexuality of a Hybrid.‡—M. L. Trabut describes an *Ophrys* intermediate between *O. tenthredinifera* and *O. scolopax* which showed a transformation in some of the flowers of two petals into two stamens, or, in other words, a strengthening of the sexuality—which is the reverse of what is generally found in most hybrids.

Fertilization of Arum and Dracunculus.§—According to Prof. G. Arcangeli, the fertilization of the flower of *Dracunculus vulgaris* (*Arum Dracunculus*) is effected mainly by necrophilous Coleoptera, attracted by the powerful odour which exhales from the open spathe, and chiefly by *Saprinus nitidulus*, the species next in efficiency being *S. subnitidus*, *Dermestes undulatus*, and *D. Frischii*.

Prof. F. Delpino,‖ on the other hand, adduces arguments in favour of the view that these Coleoptera-play but a subordinate part in the pollination, the chief agents being carnivorous flies, principally *Calliphora vomitoria* and *Sarcophaga carnaria*.

Prof. Arcangeli ¶ replies to the observations of Delpino, classing *Dracunculus* among necrocoleopterophilous plants, along with *Rafflesia*, *Amorphophallus*, *Hydnora abyssinica*, and others.

The flowers of *Arum pictum* are, according to Sig. U. Martelli,** strongly proterogynous, and exhale, when open, a most powerful odour of human excrement, which attracts insects belonging to various orders to perform the function of pollination.

Fertilization of Brassica oleracea.††—Dr. R. Cobelli enumerates as many as fifty species of Apidæ, which he has observed visiting the flowers of different varieties of the cabbage, and which may possibly take part in the pollination of the stigma.

* Oesterr. Bot. Zeitschr., xl. (1890) p. 1–7.
† Bull. Scient. France et Belgique, 1889, pp. 53–75 (1 pl.). See Biol. Centralbl., x. (1890) p. 19.
‡ Comptes Rendus, cx. (1890) p. 480.
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 52–7. Cf. this Journal, 1883, p. 382.
‖ Malpighia, iii. (1890) pp. 385–95.
¶ T. c., pp. 492–507.
** Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 129–32.
†† Verhandl. K. K. Zool. Bot. Gesell. Wien, xl. (1890) Abhandl., pp. 161–4.

Germination of Jerusalem Artichoke.*—Mr. J. R. Green states that during the germination of the Jerusalem artichoke the tubers develope a ferment which is capable of transforming inulin into sugar. It can be extracted from the tubers by glycerol, and can be artificially formed in them by heating for twenty-four hours at 35° C. The sugar formed does not crystallize, and reduces less readily than dextrose or levulose.

(2) Nutrition and Growth (including Movements of Fluids).

Transport of Reserve-materials from the Endosperm to the Embryo.†—Herr W. Hirsch describes the contrivances for the transmission of the reserve food-material from the endosperm (or perisperm) of albuminous seeds to the embryo on germination. These may be arranged under four heads:—(1) In large seeds where the embryo is small and more or less nearly central, the reserve-cells of the endosperm are more or less elongated, and radiate towards the embryo. (2) In very small seeds in which the endosperm consists of only a very few layers of cells, no such elongation occurs, but the walls of the cells are often very strongly pitted. (3) The cell-walls of the endosperm-tissue are very thin, and its cells are brought into contact with all parts of the embryo by the spirally-coiled form of the latter. (4) The elongation and radial arrangement of the endosperm-cells is accompanied by the presence of a well-developed absorbing organ.

In all albuminous seeds which have not a special absorbing-organ, its functions are performed by the layers of the endosperm which are in immediate contact with the embryo possessing the property of swelling up strongly, their contents being then transferred to the epiderm of the embryo.

Relation between Temperature and Growth.‡—Herr E. Askenasy describes in great detail the results of a series of experiments to determine the relationship between growth and temperature in the case of roots of young plants of maize. The optimum temperature was found to be between 26° and 29° C., the slowest growth at this temperature being 1·7, and the most rapid 3·8 mm. in an hour. He asserts that in all circumstances the growth of the protoplasm is the primary phenomenon, the growth of the cell-wall being entirely dependent on it. The turgidity remains the same at different temperatures, and therefore cannot be the cause of the variation of the rate of growth with the temperature. The author does not think that recent observations prove the impossibility of the growth of the cell-wall by intussusception.

Growth of the Leaf-stalk in Water-plants.§—Prof. G. Arcangeli has attempted to investigate the laws by which the stalks of floating leaves adapt themselves as to length to the depth of the water in which they grow, the growth ceasing when the lamina reaches the surface. In the case of *Euryale ferox* he believes that this is mainly due to the traction on the tissues of the leaf-stalk resulting from the lamina of the leaf

* Ann. Agron., xv. p. 569. See Journ. Chem. Soc., 1890, Abstr., p. 656.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 1–8.
‡ T. c., pp. 61–94.
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 121–9, 300–3 (1 fig.).

being of a less specific gravity than water, owing to the abundance and size of its intercellular spaces, this traction ceasing when the leaf has reached the surface. A similar explanation, with some modifications, can be offered in those cases where the direction of the leaf-stalk is oblique rather than vertical to that of the lamina. In no case, he believes, is this arrest of growth due to chemical causes, i.e. to the difference in proportion of the oxygen in the air contained in solution in the water and in the atmosphere.

Theory of Growth in Height.*—Prof. Weber proposes a mechanical theory for the energy of a plant in relation to its growth in height. Representing this energy as K, the weight of the plant as P, and the height as H; then K = P H in meterkilograms; and when K remains uniform, P and H are always reciprocals of one another. The author believes that the force which determines the mechanical equivalence of the annual sum of the work in the movements of the sap must be sought for not in "root-pressure," but in the merismatic tissue or its protoplasm.

Apparatus for illustrating the Growth of Plants.†—Dr. J. Kündig describes and figures an apparatus which he has constructed for the purpose of demonstrating the phenomena of growth in length of plants. It consists of a number of metal tubes, arranged one within another in telescope-fashion, the uppermost of which represents a growing point and the rest internodes of different lengths. The whole is inclosed within a box with an opening at the top, through which the system of metal tubes emerges by the turning of a key, their successive appearance and separation representing the development of the internodes.

Transpiration and Assimilation.‡—M. G. Curtel describes a very simple apparatus by means of which the variations in transpiration can be studied. A U-shaped tube is taken, and two corks of caoutchouc; into one of the corks a capillary tube is inserted, and through the other a plant (of rye) is let into one of the arms of the tube. The apparatus is filled with water, the corks fixed and waxed, and the variations of the column of liquid in the capillary tube indicate the progress of the transpiration.

Assimilation of Carbon by Green Plants.§—Mr. E. H. Acton has conducted a series of experiments in entirely removing the starch from the leaves and tissues of growing plants, by placing them either in the dark or under a bell-jar with substances which entirely remove all carbon dioxide from the air, and then supplying them with various organic compounds as food-materials. The general results arrived at are that green plants cannot normally obtain carbon for assimilation from any substances except carbohydrates or bodies closely related to them, not from aldehydes or their derivates, and not even from all carbohydrates. A compound may be a source of carbon when supplied to the leaves, but not when supplied to the roots, and *vice versâ*. Ordinary

* SB. Bot. Verein München, Dec. 9, 1889. See Bot. Centralbl., xli. (1890) pp. 10 and 42.
† Bot. Centralbl., xli. (1890) pp. 203–5 (1 fig.).
‡ Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 7–16 (1 fig.).
§ Proc. Roy. Soc., xlvii. (1890) pp. 150–75 (3 figs.).

non-parasitic green plants have, however, to a large extent, lost the power of using such substances as a source of carbon. The author considers that his experiments do not settle the question whether the immediate result of the mutual decomposition of carbon dioxide and water by plants is formic aldehyde.

Cause of the Movement of Water in Transpiring Plants.*—Dr. J. Boehm adduces additional arguments in favour of his view that the absorption of water in transpiring plants is not due primarily to endosmotic action in the root, or to differences in the pressure of the air. The absorption of water through the roots, and the ascent of sap are, on the other hand, in his view, a capillary function of the vessels, which may be regarded as a continuation of the capillary spaces in the soil. The ascent of sap takes place only in the outermost alburnum, and is exceedingly rapid when transpiration is excessive. The sap-conducting vessels of Conifers are the tracheïd bundles, the elements of which are in open connection with one another.

Transpiration.†—Herren E. & J. Verschaffelt state that, other conditions of light, temperature, &c., being the same, transpiration is greater in an air containing no carbonic acid than it is in the ordinary atmosphere.

(3) Irritability.

Chemotactic Irritability.‡—Herr B. Stange has made a series of observations on the sensitiveness to the presence of various chemical substances of the zoospores of Saprolegniaceæ and the myxamœbæ of Myxomycetes. The results confirm de Bary's general statement that parasitism and saprophytism are influenced by the chemical composition of the host or medium.

The experiments on Saprolegniaceæ were made on a species belonging to the *Saprolegnia ferax* group, grown, with due precautions, on the dead bodies of flies. They determined the fact that, while certain other substances exercise a smaller or greater attractive or repulsive influence on the zoospores, it is the phosphates in the decaying body of the insect or in the nutrient fluid, and not the compounds of nitrogen or carbon, which excite most strongly the sensitive movements of the zoospores; and there is, for this purpose, an optimum concentration for phosphoric acid itself and for each of its salts. No other free acid produced the same effect. Whether the effect is attractive or repulsive depends on the concentration of the solution. Neither free oxygen nor variations of temperature had any considerable influence on the irritability.

The Myxomycetes observed were chiefly *Chondrioderma difforme* and *Æthalium septicum*. The results differed materially from those obtained with *Saprolegnia*. Phosphoric acid and its salts, citric acid, tannic acid, glycerin, cane-sugar, and other substances exercised no attractive force on the myxamœbæ of *Chondrioderma;* on the other hand, malic and

* Verhandl. K. K. Zool-Bot. Gesell. Wien, xl. (1890), Abhandl., pp. 149–60 (3 pls.). Cf. this Journal, 1886, p. 824.

† Bot. Jaarboek (Gent), ii. (1890) pp. 306–24 (2 pls.). See Bot. Centralbl., xlii. (1890) p. 373.

‡ Bot. Ztg., xlviii. (1890) pp. 107–11, 124–7, 138–42, 155–9, 161–6.

lactic acid and their salts acted powerfully, butyric acid and asparagin with less energy; the action is again attractive or repulsive, according to the concentration. With *Æthalium septicum* positive results were also obtained with valerianic and propionic acids. The plasmodes of this species are apparently influenced by the same irritants as the myxamœbæ.

(4) Chemical Changes (including Respiration and Fermentation).

Chemical Changes during Germination.*—Mr. H. T. Brown and Dr. G. H. Morris describe the phenomena of metabolism which take place during the germination of the grain of some grasses, especially barley. They state that a disintegration and dissolution of the cell-walls of the endosperm always precede any attack upon the cell-contents, and that this depends on the production during germination of a special cellulose-dissolving or "cyto-hydrolytic" enzyme, which, like diastase, is soluble. Owing to the non-diffusible nature of the "amylo-hydrolytic" enzyme, or diastase, the previous breaking-down of the cell-wall is a necessary prelude to the dissolution of the contained starch-grains. The appearance of both these hydrolysts is due to a specialized secretory function of the layer of columnar epithele which covers the outer surface of the scutellum.

The authors support the view that the relation of the embryo to the endosperm is that of parasite to host, and they found it possible to cultivate the excised embryo after separation from the endosperm, on suitable media. Of all the host-substances thus tried, cane-sugar has by far the greatest nutritive power. Other carbohydrates, as invert-sugar, dextrose, levulose, maltose, raffinose, galactose, and glycerol, have more or less nutrient value, while milk-sugar and mannitol do not in any way contribute to the growth of tissue in the young plant. The authors believe that the transformed starch of the endosperm is absorbed by the embryo in the form of maltose, and that the seat of the production of the cane-sugar which germinated grain contains is the tissues of the embryo itself.

Prof. J. R. Green † has made a series of experiments on the same subject in the case of the castor-oil plant (*Ricinus communis*). He finds in the resting seeds a ferment or zymogen, which is readily developed into an active condition by warmth and weak acids, the results of its activity being the splitting up of the oil with formation of glycerin and (chiefly) ricinoleic acid. The proteids of the seed, which consist of globuline and albumose, are split up by another ferment with formation of peptone and asparagin. During the progress of germination there is also liberated in the endosperm a rennet-ferment of considerable vigour. The author states that the only products which enter the embryo during germination are a crystalline acid, sugar, possibly some peptone, and asparagin.

Transformation of the Alkaloids during Germination.‡—From observations made chiefly with strychnine, brucine, daturine, and

* Journ. Chem. Soc., 1890, pp. 458–528 (2 pls.).
† Proc. Roy. Soc., xlvii. (1890) pp. 146–7.
‡ Comptes Rendus, cx. (1890) pp. 88–90.

caffeine, Herr E. Heckel concludes that the alkaloids in the seeds are true reserve food-materials, since they are entirely transformed into assimilable substances during the process of germination. The experiments on caffeine were made chiefly with *Sterculia acuminata*, those on the three other alkaloids with *Strychnos nux-vomica* and *Datura Stramonium*. In all cases the alkaloids contained in the cotyledons or in the embryo had completely disappeared as soon as the seedlings had attained a considerable size, the products of the transformation of caffeine being glycophyll and potassium nitrate. A similar result was obtained with the eserine contained in the seeds of *Physostigma venenosum*.

Fixation of Free Nitrogen.*—Sir J. B. Lawes and Prof. J. H. Gilbert have repeated Hellriegel and Wilfarth's experiments † on the source from which leguminous plants obtain their nitrogen, and their conclusions are, in the main, in harmony with those of these observers. While with Cruciferous, Chenopodiaceous, Graminaceous, and all other cultivated crops except those belonging to the Leguminosæ, all their nitrogen would appear to be derived from the nitrates in the soil, this is apparently not the case with Leguminous plants, those on which the observations were made being chiefly peas, lupins, clover, vetches, and lucerne. The authors consider that there is no evidence whatever that these plants have any power to fix the free nitrogen of the atmosphere; but that the tubercles on the roots are the organs through which a large proportion of the nitrogen is absorbed, the bacteria which infest these tubercles utilizing and fixing the free nitrogen from the soil, and thus forming nitrogenous compounds which are taken up by the host. The most striking results were obtained with the yellow lupin.

Formation of Nitrates.‡—Herr Serno finds nitric acid present in almost all plants, the largest quantities occurring in the Malvaceæ, Cruciferæ, Papaveraceæ, Convolvulaceæ, Labiatæ, Compositæ, and Urticaceæ. In other plants it occurs only in the roots, and especially in the newly formed absorbing roots. In older roots it is often absent, and always in those which carry on a symbiotic existence with fungi. The author found nitric acid present in the greatest abundance in aquatic plants, usually, but not always, in those that grow in sandy situations, always wanting in marsh-plants. In many perennial plants the nitrates are stored up in winter as a reserve-material; in others they are formed only in the spring. In annual plants they occur abundantly in all parts. The function of the nitric acid is believed by the author to be connected with the formation of amides, especially of asparagin.

M. Berthelot § refers to the observations of Heckel as to the simultaneous disappearance of caffeine and formation of potassium nitrate in the seeds of kola, as confirming his view that the formation of nitrates in plants is a similar process, from a physiological point of view, to the formation of nitrates in the soil, and is equally due to the action of microbes.

* Proc. Roy. Soc., xlvii. (1890) pp. 85–118. Cf. this Journal, 1888, p. 261.

† Cf. this Journal, 1889, p. 781.

‡ Landwirthsch. Jahrb., xviii. (1889) pp. 877–905. See Bot. Centralbl., xlii. (1890) p. 156.

§ Comptes Rendus, cx. (1890) p. 109.

Respiration of Roots.*—Mr. J. Bancroft figures the aerial roots of a number of shore-plants, and describes their function in assisting in the respiration of the plant.

γ. **General.**

New Insectivorous Plant.†—Dr. D. D. Gonzalez describes the structure of the gigantic flowers of *Aristolochia grandiflora* of Central America. The swollen base of the corolla-tube forms a hollow chamber, within which are found countless numbers of the dead bodies of insects, in various stages of decomposition. He believes that these are actually digested, and the products absorbed into the tissues of the plant, though he is not yet able to describe the pepsin-producing glands by means of which the digestion is effected.

Atavism of Plants.‡—MM. le Baron d'Ettinghausen and Prof. Krasan call attention to the heteromorphism in the form of the leaves of the oak and the beech when injured by excessive cold, or by the attacks of caterpillars or other insects. Under these conditions the injured branches frequently put out shoots which bear leaves very different in form and size from the normal leaves of the species, or of other existing species of the same genus, and more or less resembling those of extinct species; and the authors regard this as an illustration of atavism or reversion to an ancestral type.

Adaptation of Grasses to Dry Climates.§—Herr E. Hackel describes the peculiarities by means of which, in addition to the anatomical characters of the leaves, grasses are enabled to flourish in a very dry climate. These are mainly two, viz.:—(1) The formation of bulbs or tubers on the lower part of the stem, frequently on as many as three or four of the lowest internodes; (2) The formation of "tunics," i. e. of a number of dry sheaths surrounding the lowest internodes which are thrown off in succession. A list of grasses is given which display each of these characters, and the special arrangements are described in detail.

Value of Chlorine to the Plant.‖—Herr C. Aschoff gives the percentage of chlorine in different parts of the seed and seedling of *Phaseolus multiflorus*, *P. vulgaris*, and *Zea Mays*, and deduces, as the result of a series of experiments, that chlorine is an essential constituent of the food-material of these plants.

"Pock-disease" of Tobacco.¶—Herren D. Iwanowsky and W. Poloftzoff have determined that the disease known by this name, which is very destructive to tobacco-plantations, appearing as brown spots or streaks on the leaves, is not due to the attacks of a parasitic fungus, but either to excessive moisture in the soil or to sudden evaporation after wet weather. It occurs also on allied plants, such as *Datura Stramonium* and *Hyoscyamus niger*, and is probably widely distributed through the vegetable kingdom.

* Rep. Australasian Assoc. for the Advancement of Science, 1889, pp. 327-3. (10 pls.). See Bot. Centralbl., xlii. (1890) p. 341. Cf. this Journal, 1887, p. 111.
† Journ. de Micrographie, xiv. (1890) pp. 109-13.
‡ Arch. Sci. Phys. et Nat., xxiii. (1890) pp. 76-81.
§ Verhandl. K.K. Zool. Bot. Gesell. Wien, xl. (1890) Abhandl., pp. 125-38.
‖ Landwirthsch. Jahrb., xix. (1890) pp. 113-41 (3 pls.). See Bot. Centralbl., xlii. (1890) p. 212.
¶ Mém. Acad. Imp. Sci. St. Pétersbourg, xxxvii. (1890) 24 pp. and 3 pls.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Male Prothallium of Azolla.*—Herr V. W. J. Bielajew describes the germination of the microspore of *Azolla* (*filiculoides*). The processes show a very close resemblance to those in *Salvinia*, and furnish an additional argument for dividing the Hydropterideæ (Rhizocarpeæ) into the two families of Salviniaceæ and Marsileaceæ.

From the exospore there first protrudes a tubular outgrowth, which pierces the spongy tissue of the massula, and which is curved as in *Salvinia*. At the base of this tubular prothallium a small lens-shaped cell is separated, which is followed by a large tubular cell; at the opposite upper end of the prothallium lies a rather large sterile cell, and between the two is a mass of fertile cells (producing antherozoids) arranged in two layers, each layer consisting of four cells. The cells of the upper layer are covered, on the ventral side of the prothallium, by a flat lid-cell; and a small sterile cell also lies on the dorsal side of the prothallium next the lower layer. The chief difference between the structure of the male prothallium in *Salvinia* and in *Azolla* lies in the fact that in the former genus the two antherids are separated from one another by a large sterile cell; while in the latter the fertile cells are united into a single group.

Fructification of Marsilea.†—From an examination of the normal fruits of *Marsilea macra*, and of abnormal developments of that species and of *M. hirsuta*, Herr M. Büsgen draws the conclusion that the fructifications are homologically branches of leaves; but that each fruit does not correspond to a pinna, but is equivalent to an entire sterile leaf. As in the isosporous Filicineæ, the sporanges are developed from superficial cells of the rudiment of the fructification.

Germination of the Megaspore of Isoetes.‡—Observations on the earliest stages of germination of the megaspore of *Isoetes echinospora* by Dr. D. H. Campbell differ in some important points from the results previously recorded by Hofmeister and Farmer.§ The spores were fixed with absolute alcohol or chromic acid, imbedded in paraffin, and coloured with gentian-violet, after sections had been made with the microtome. The large, sharply differentiated nucleus lies at first in the lower posterior portion of the spore; but, after the first stages of division, the new nuclei are found near its apex; here they continue to divide until they amount to from 30 to 50; they are found exclusively in the parietal protoplasm, much more numerous in the apical region, and are entirely absent from its central and lower portion. The nuclei are sometimes connected by fine threads; the cell-plates are formed between them, and soon become transformed into firm membranes; the formation of septa commences at the apex, and advances towards the base of the

* SB. Warschauer Naturf.-Gesell., Oct. 27, 1889. See Biol. Centralbl., x. (1890) p. 287.

† Flora, lxxiii. (1890) pp. 169–82 (1 pl.).

‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 97–100 (1 pl.).

§ Cf. this Journal, 1889, p. 551.

spore; and the apex soon becomes occupied by a cellular tissue. The process corresponds closely to that of the formation of endosperm in seeds; and the author holds that *Isoetes* presents, among Pteridophyta, the nearest relationship to Flowering Plants.

Affinities of the Filicineæ.*—Prof. D. H. Campbell dissents from Bower's theory† that the Hymenophyllaceæ represent the most primitive form of the Filicineæ, and are probably derived from some form intermediate in character between existing bryophytes and the higher green algæ. From a comparison of the oophytic and sporophytic generations in the various orders, he has come to the conclusion that the Ophioglossaceæ must be placed at the base of the Filicineæ; from them sprang two main branches, one through the Marattiaceæ, possibly terminating in the Cycadeæ, the other through the Filices, giving rise to two branches ending in the two heterosporous groups, the Marsiliaceæ and the Salviniaceæ. According to this view the Hymenophyllaceæ must be regarded as a degenerate group from the leptosporangiate Filices, the simple prothallium and sporophyte being the result of their semiaquatic habit.

Oophyte of the Gleicheniaceæ.‡—Herr N. W. P. Rauwenhoff has succeeded in germinating the spores of several species of *Gleichenia*, and in following the development of the archegones and antherids on the prothallium, which differs in no essential point from that in other ferns. The growth of the prothallium is exceedingly slow. It is at first filiform, and the antherids appear near its apex; subsequently it becomes club-shaped, and they then make their appearance over almost its whole surface, even on the upper side. Finally it becomes heart-shaped, and the archegones are then formed chiefly near the apex on the under side. Occasionally two oospheres are impregnated on the same prothallium. The epidermal cells of the root spring from the lateral segments and not from the apical segments of the apical cell. There is a strong tendency towards diœcism in the prothallium, large numbers of archegones being borne on prothallia which produce only a single antherid or none at all. The prothallium sometimes grows to a great size, remaining quite barren, and not unfrequently exhibiting prolification. The spores have three coats.

Sclerotized Elements in the Tissues of Ferns.§—Dr. G. Walter has investigated the structure, chemical nature, and development of the brown-walled sclerotized elements in the tissue of thirty-eight species of fern, with special reference to the "supporting bundle" of Russow.

While in the aerial stem of the tree-ferns the predominant form of the sclerenchyme is prosenchymatous, in the creeping rhizome of ferns with a dorsiventral structure it has chiefly a parenchymatous character. The "supporting bundles" which frequently occur in the creeping rhizome when the leaves are in two rows consists of isolated, usually parenchymatous strings of sclerenchyme in the fundamental tissue.

* Bot. Gazette, xv. (1890) pp. 1–7.
† Cf. this Journal, *ante*, p. 66.
‡ Arch. Néerl. Sci. Exact. et Nat., xxiv. (1890) pp. 157–231 (7 pls.).
§ Luerssen u. Haenlein's Biblioth. Bot., Heft 18 (1890) 21 pp. and 3 pls.

They were found in sixteen out of the thirty-eight species examined, presenting the appearance of black shining exceedingly narrow threads varying greatly in size, between 0·4 and 18 mm. in length and between 0·06 and 0·35 mm. in thickness. In almost all cases the cells from which the fundamental tissue and the supporting bundle originate were found to be uniform in size and form; in only two species (*Pteris aquilina* and *Oleandra hirtella*) was there a differentiation of the elements of the primary meristem. With the appearance of the brown substance the merismatic power of the cells ceases. The cells become at a late period periodically filled with starch, like the surrounding parenchymatous cells.

The sclerotized brown membrane, which occurs only in the Filicineæ, is extraordinarily resistant to acids and other chemical agents. Treatment with eau-de-Javelle showed that the colour and hardness are not due to lignification, but to the deposition of a foreign brown substance in the membrane. The chemical nature of this substance appears to be identical with that known as phlobaphene belonging to the group of humin-substances, which has been obtained in many instances from bark. The main physiological purpose of these layers appears to be to replace the cork which is never found in ferns.

Stem of Ferns.*—M. Leclerc du Sablon contrasts the structure of the stem of flowering plants with that of ferns, and then takes special instances of the latter, and describes them in detail. In ferns, in place of the single central cylinder surrounded by cortex, we have several fibrovascular bundles, each with a special endoderm in the middle of an irregular cortex. The collateral bundles of Phanerogams are then contrasted with the bicollateral or concentric fibrovascular bundles of ferns; and, in the various forms of the latter, the following will be found to be common to all. In a developed stem, if nothing has been destroyed:—(1) there will be towards the base a conical region, the oldest part, and (2) a cylindrical region which elongates indefinitely. The passage of the root into the stem is always the same. The first root incloses two xylem-bundles and two phloëm-bundles; in passing into the stem, the two xylem-bundles unite by their base, and the two phloëm-bundles form a complete ring round the xylem. Certain species have pith in the centre of the central cylinder, in the middle of the xylem, and this is composed of parenchyme (*Polypodium aureum*, *Osmunda regalis*). In other cases (*Pteris aquilina*, *Nephrodium molle*), the tissue in the interior of the xylem is formed of phloëm-elements together with parenchyme.

Transformation of Roots into Shoots in Ferns.†—From experiments made chiefly on *Asplenium esculentum*, *Platycerium alcicorne*, *P. stemmaria*, *P. Hilli*, and *P. Willinkii*, Herr S. Rostowzew has determined that the root can be transformed directly into a shoot, the apical cell of the root becoming the apical cell of the shoot, and being no longer segmented in the direction of the root-cap, but only on the three other sides. The vascular bundle passes directly into the shoot, and undergoes

* Ann. Sci. Nat., xi. (1890) pp. 1–15 (2 pls.).
† Flora, lxxiii. (1890) pp. 155–68 (1 pl.).

similar changes to those in the hypocotyl of the embryo of higher plants; the bundle-sheath gradually disappears in the young shoot; the endoderm passes without change; the pericycle is divided into several layers; the xylem of the diarch bundle is separated from the pericycle by narrow phloëm-cells; a large portion of the xylem in the centre of the bundle remains unlignified; and the bundle gradually assumes the concentric structure with phloëm on each side of the xylem; later, from this circular bundle proceeds one of a horseshoe form, dividing finally into two, which present the character of normal stem-bundles. Both primary and secondary roots can be transformed into shoots; and the shoot may then either be placed at the end of a root or may spring from it laterally; in the latter case its position shows that it is actually a lateral root, and not an adventitious shoot. In *Asplenium* the root-cap is soon burst and thrown off from the apex of the metamorphosed root; in *Platycerium* it remains attached for a longer period to the apex of the shoot.

Muscineæ.

Anatomy of the Capsule of Mosses.*—Herr E. Bünger has made a detailed examination of the structure of the sporange in a great number of mosses, especially as regards the stomates and the assimilating tissue.

The stomates are almost always limited to the lower portion or neck of the sporange. While usually bicellular, as in most flowering plants, unicellular stomates occur in *Funaria*, *Physcomitrium*, *Buxbaumia aphylla*, *Physcomitrella*, &c., and three- or four-celled, probably functionless, stomates, in the Hypnaceæ and Polytrichaceæ. In *Mnium* they are depressed below the epiderm from the small size of the guard-cells; while in some species, as in *Buxbaumia aphylla* and species of *Orthotrichum*, they project above the epiderm and form an external breathing-pore. The pore or orifice is generally characterized by its very small size, and especially its short length. The fissure or the division-wall between the two guard-cells is almost invariably parallel to the longer axis of the sporange. The mechanical arrangement for opening and closing the stomate is described in detail in a number of species.

The assimilating tissue is least strongly developed in those mosses in which the stomates are either altogether wanting, or are functionless, as in the Sphagnaceæ, where the whole of the sporange is composed of aquiferous tissue without any air-spaces, and the Andreæaceæ, which are also destitute of stomates. A variety of intermediate stages are described in detail, leading up to the fullest development of the assimilating tissue, in the Polytrichaceæ. The Cleistocarpæ—*Archidium*, *Ephemerum*, *Physcomitrella*, *Phascum*, *Sphærangium*—stand even below *Sphagnum* in the complete suppression of the assimilating and aquiferous tissue; and the stomates are also often entirely wanting.

* Bot. Centralbl., xlii. (1890) pp. 194–9, 225–30, 257–62, 289–96, 321–6, 353–6 (1 pl.).

Characeæ.

Rabenhorst's Cryptogamic Flora of Germany (Characeæ). — An admirable monograph of the Characeæ of Germany, Austria, and Switzerland, by Dr. W. Migula, has been commenced as a section of this work, four parts being now published. It commences with a very full account of the morphology and history of development of the family, which the author regards as a primary division, distinct from Algæ on the one and Muscineæ on the other hand. He suggests that their origin may possibly be in the Chlorophyceæ near to *Coleochæte*, the Characeæ or Charophyta and the Bryophyta being two distinct branches. The family is, as usual, divided into the two sub-families Nitelleæ and Chareæ, the former comprising two genera, *Nitella* and *Tolypella*, and the latter four, *Tolypellopsis*, *Lamprothamnus*, *Lychnothamnus*, and *Chara*. The third part is occupied by the species and sub-species of *Nitella*, thirteen species being described, and a large number of sub-species, some of which are also figured. The fourth part is devoted chiefly to the six species of *Tolypella*, which are treated with equal detail, and with the most thorough knowledge of the subject; it contains also the diagnosis of the sub-family Chareæ and of the new genus *Tolypellopsis* (v. Leonh.) Mig., in which there is no cortication of the stem or leaves and no stipular structures, but in their place a stronger development of three small cells of the node; the leaves have only one or two nodes, and the leaflets are often entirely suppressed. The antherids are sessile and solitary on the ventral side of the leaf; the oogones occupy the same position, solitary or in pairs, with a very short pedicel-cell; the neck-portion of their cortical cells is elongated into a beak; the crown small, composed of narrow cells, not erect, and narrowing at their apex. The illustrations throughout are copious and exceedingly clear.

Algæ.

Formation of Vacuoles in Algæ.*—From observations made on the mode of formation of the vacuoles in the reproductive cells of a large number of Algæ belonging to different families, Herr F. A. F. C. Went confirms his previous conclusion that they are formed only as the result of the division of vacuoles already in existence. The different modes may be arranged under various heads.

To the first group belong the tetrasporanges and carpospores of the Florideæ, the tetrasporanges of *Dictyota*, and the oogones of the Fucaceæ. When young these cells contain a parietal layer of protoplasm, with chromatophores, often arranged round the nucleus, which is hung up in the centre of the large vacuole by threads or plates of protoplasm. The vacuoles decrease in size and increase in number by the multiplication of these threads or plates, the chromatophores increasing in number at the same time by division. On germination the vacuoles and chromatophores distribute themselves through the newly formed cells, so that each cell of the young alga contains only one or a few of them.

The second group includes those cases where a remnant of the protoplasm and of the vacuole remains over as a central vesicle, as in

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 299–366 (4 pls.). Cf. this Journal, 1889, p. 674.

the formation of the zoospores of *Chætomorpha aerea*, *Acetabularia mediterranea*, *Codium tomentosum*, and *Halimeda Tuna*, or in which the entire protoplast is divided into numerous smaller ones, as in the formation of the swarm-cells of *Sporochnus pedunculatus*, *Arthocladia villosa*, and *Derbesia Lamourouxii*. The young sporange contains a central vacuole and a parietal layer with imbedded chromatophores, and one or more nuclei. As the nuclei and chromatophores multiply, strings or plates of protoplasm are formed traversing the vacuole and breaking it up. The chromatophores, each with its own nucleus, vacuoles, and cytoplasm, collect into small groups; between these groups colourless lines make their appearance, and each protoplast thus formed developes into a zoospore. The antherozoids of the Fucaceæ are formed in the same way.

A third group consists of plurilocular sporanges, of which *Ectocarpus confervoides* may be taken as a type. A cell containing a parietal layer of protoplasm, with chromatophores, nucleus and vacuole, divides into a mass of cells, each of which again contains, as the result of division, all the organs of the protoplasm. The contents of each cell becomes a zoospore. Similar phenomena characterize the formation of the pollinoids of the Florideæ, and the antherozoids of the Characeæ and of the higher Cryptogams.

In the gemmæ of such algæ as *Sphacelaria tribuloides* each cell contains a nucleus and a layer of protoplasm with chromatophores and vacuoles, which bodies have been formed by division out of the mother-cells of the gemma.

Lemaneaceæ.*—Prof. G. F. Atkinson publishes a monograph of the United States' species of Lemaneaceæ, which he unites into the single genus *Lemanea*, of which he describes seven species, five belonging to the subgenus *Lemanea* proper (two of them new), and two to the subgenus *Sacheria*, with several varieties.

The oophyte has three distinct successional forms:—(1) A permanent cellular or confervoid prostrate form, the former consisting of an irregular mass of polyhedral cells spread over the surfaces of rocks; (2) a *Chantransia*-form, usually developed as erect lateral shoots from the prostrate form, rarely direct from the spore; it consists of branched filaments composed of a single series of elongated cells, the endochrome in some species coloured violet; but does not produce gonids; these two forms constitute the protoneme of the plant; (3) the sexual shoot, originating as a special lateral shoot from the *Chantransia*-form. This is a hollow or tubular shoot, containing a system of delicate filaments, the apparatus for fructification. The wall is more or less cartilaginous, and is composed of three layers—the medullary, consisting of a single layer of comparatively large cells, an intermediate layer of somewhat smaller polyhedral cells, and a cortical layer of small prismatic cells, rich in colouring matter. It derives its nourishment from the *Chantransia*-form, but soon becomes independent by the development of rhizoids at its base. The apparatus for fructification consists of a central axis, ray-cells, and generative filaments, with the tie-cells which unite them to the medullary layer. The development of each of the

* Ann. of Bot., iv. (1890) pp. 177–229 (3 pls.).

three forms is described in detail, with its variations in the two subgenera.

The antherids arise from specialized cells which terminate the generative filaments. Each antheridiophore produces either one or two antherids. They are oblong thin-walled sacs, and each contains a single oblong hyaline non-motile pollinoid ("spermatozoid"). The procarp also arises as a special branch from the generative filament. It consists of from 3–10 oval cells; the terminal or carpogenous cell is surmounted by the trichogyne, which penetrates through the intermediate layer and the cortex to the outside of the sexual shoot. Fertilization takes place by contact of the pollinoid with the apex of the trichogyne; its protoplasm is probably absorbed by the trichogyne, and conveyed to the carpogenous cell. After fertilization the carpogenous cell developes, by budding, a whorl of cells, the ooblastema-filaments, which soon begin to branch, and produce chains of carpospores. Both apogamy and apospory were observed in several species.

The subgenus *Sacheria* differs from *Lemanea* proper mainly in the antherids being in well-defined patches, rarely confluent; the procarps consist of only from 3 to 4 cells, always developed in and near the antherid-zone; the generative filaments are closely applied to the wall of the tube throughout their entire length; the basids or basal sterile cells of the ooblastema-filaments being elongate and cylindrical; and the prostrate form of the protoneme being mainly cellular.

Bladders of Fucaceæ.*—According to Prof. N. Wille, the structure of the bladders of the Fucaceæ belongs to two different types:—(1) In *Fucus vesiculosus* and *Ozothallia nodosa* the tissue in which they are formed is composed of much-branched filaments; (2) In *Halidrys siliquosus* and *Cystoseira ericoides* the filaments of which it consists are parallel, and but slightly branched. The proportion of oxygen in bladders which still remained immersed in the water amounts to as much as 35–37 per cent.; they never contain any carbon dioxide.

Macrocystis and Thalassiophyllum.†—Herr O. Rosenthal describes in detail the vegetative structure of these two genera of Laminariaceæ, which he regards as constituting a special group, contrasted with a second group formed of *Laminaria*, *Alaria*, *Costaria*, and *Agarum*. The distinguishing feature lies in the segmentation of the frond, this again depending on a difference in the position of the growing point—in the first group lateral on the margin of the lamina, in the second group opposite the middle of the base of the leaf, at the point of junction between stem and lamina. In *Macrocystis* the leaves are in consequence inserted laterally, and are perennial, while in *Laminaria* they are terminal, and are usually thrown off annually; their duration is not known in the other genera of the group. In *Macrocystis* and *Thalassiophyllum* the growing point divides into two unequal halves, which is not the case with *Laminaria*. In *Macrocystis* and *Laminaria* the lamina splits up into narrow strips; while the formation of holes in that of *Agarum* corresponds somewhat to a similar process in *Thalassiophyllum*.

* Biolog. Fören. Stockholm Förhandl., i. pp. 63–5. See Bot. Centralbl., xlii. (1890) p. 110.

† Flora, lxxiii. (1890) pp. 105–47 (2 pls.).

Vaucheria-galls.*—Mr. A. W. Bennett gives a *résumé* of the literature of the so-called *Vaucheria*-galls, caused by the attack on various species of *Vaucheria* of the rotifer *Notommata Werneckii.* The galls are, in all probability, at least very often, a fertile branch prevented from forming oogones and antherids by the attacks of the parasite.

Mr. W. Narramore † contends that the occasional septation of the filaments of *Vaucheria* is not, as usually stated, always the result of injury. He also describes the occurrence of peculiar disc-shaped protoplasmic bodies within the filaments, whether septated or unseptated; and the formation of the so-called "galls" on *V. dichotoma.*

Cephaleuros, Phycopeltis, and Hansgirgia.‡—Dr. G. B. de Toni and Prof. F. Saccardo give diagnoses of these three genera of epiphytic algæ, and of their known species, viz.:—*C. virescens* Kze., *P. epiphyton* Mill., *P. arundinacea* De Ton., and *H. flabelligera* De Ton. *Cephaleuros* Kze. they regard as perfectly autonomous, and not a form of *Strigula*, although it may possibly constitute the gonids of some species of this genus of lichens; while the gonids of other species of the genus belong to *Phycopeltis* or *Protococcus.* Cunningham's genus *Mycoidea* must be sunk in *Cephaleuros.*

M. E. de Wildeman § agrees with the opinion of Hariot and De Toni that *Mycoidea* Cunn. is a synonyme of *Cephaleuros*, and that the name *Mycoidea parasitica* Cunn. must be suppressed in favour of *Cephaleuros virescens* Kze.

Reproduction of Codium.‖—Contrary to the observations of previous observers, Herr F. A. F. C. Went finds microzoosporanges and megazoosporanges of *Codium tomentosum* on the same plant, the former being later in their appearance than the latter. He was unable to detect any process of conjugation, either in the microzoospores among one another, or between these and the megazoospores.

Fungi.

Paraphyses of Fungi.¶—M. Boudier discusses the various opinions which have been brought forward as to the utility of these organs, and then points out that the paraphyses in fungi ought to be regarded as imperfect or sterile basids, and as protective organs or receptacles for reserve material.

Saccharine Substances contained in Fungi.**—M. R. Ferry gives a *résumé* of the process he adopts in order to analyse chemically the saccharine substances in fungi. This consists in first drying the material and then reducing it to small fragments, when it is boiled with alcohol (90 per cent.) for a few minutes. It is then filtered into porcelain capsules and allowed to evaporate, and the residue from the evaporation

* Ann. of Bot., iv. (1890) pp. 172–4, 300–1 (1 fig.).
† Journ. Liverpool Micr. Soc., i. (1890) pp. 61–76 (2 pls.).
‡ La Nuova Notarisia, i. (1890) pp. 1–20 (3 pls.). Cf. this Journal, *ante*, p. 70.
§ Notarisia, v. (1890) pp. 953–5.
‖ Vergad. Ned. Bot. Vereen., xlviii. (1889) (1 pl.). See Bot. Centralbl., xlii. (1890) p. 111.
¶ Bull. Soc. Mycol. de France, 1890, p. x. See Rev. Mycol., xii. (1890) p. 145.
** Rev. Mycol., xii. (1890) pp. 136–40.

treated with distilled water. After some days crystals will usually appear. The conclusions drawn from numerous analyses are as follows:—(1) That mannite is nearly always present in the larger fungi, crystallizing in long fine needles. It was met with in 90 per cent. of the species examined. (2) Trehalose is less frequently present, and may be known by its hard massive crystals. It was met with in 25 per cent. of the species. (3) In some species of the genus *Amanita* chloride of potassium was met with in sufficient quantity to form crystals. (4) Glucose was met with in certain species, e. g. *Amanita valida*, *A. spissa*, *A. mappa*, *Tricholoma sulfureum*, *Russula virescens*, &c.

M. Bourquelot * confines his observations to the genus *Lactarius*, and states that other saccharine bodies besides trehalose and mannite exist in these fungi. In *L. volemus* there is a sugar analogous to mannite which crystallizes easily.

Development of Phytophthora infestans.†—By cultivating diseased potatoes in complete darkness, Herr J. Smorawski believes that he has obtained the hitherto unknown oogones of *Phytophthora infestans*, and possibly also the antherids, though he conjectures that reproduction may sometimes take place parthenogenetically.

Parasitic Fungi.‡—Dr. C. von Tubeuf describes the results of the attacks on seedling birches of *Phytophthora omnivora*, which, both on this and on other seedlings, frequently incites the formation of a third cotyledon. He also speaks of the ravages committed on *Alnus incana* by *Exoascus borealis*; on *Pinus excelsa* by *Trichosphæria parasitica*, which also attacks *Picea excelsa* and *Tsuga canadensis*; and on *Pinus Strobus* by *Lophodermium brachysporum*.

Physomyces.§—The name *Physomyces heterosporus* is proposed by Prof. C. O. Harz for an undescribed fungus, which he finds abundantly infesting manufactories of soap and candles. It forms a continuous dark brown pellicle on a warm solution of raw glycerin, with bright carmine spots; and produces stylospores varying in size from 7–8 to 9–11 μ, and sporanges 40–50 μ in size, containing spherical or shortly oval sporangiospores measuring 4–5 μ. The cell-wall is colourless; but the carmine pigment, which the author proposes to call *physomycin*, occurs in both the hyphæ and the stylospores. Although resembling Lankester's bacterio-purpurin in colour, it differs altogether from that substance in its properties, being insoluble in water, soluble with difficulty in ether, very readily in alcohol; caustic soda and potassa, hydrochloric and sulphuric acids, change it to an orange-yellow. It is cultivated readily on a decoction of apples, pears, plums, or quinces, or on horse-dung.

Dr. Harz proposes the establishment of a new order LEPTOMYCETES, of the same rank as the Oomycetes and Zygomycetes, with the following characters: — Fungi hyphomycetiformes, saprophytici v. parasitici,

* Bull. Soc. Mycol. de France, 1890, p. vii. See Rev. Mycol., xii. (1890) p. 145.
† Landwirthsch. Jahrb., xix. (1890) pp. 1–12 (1 pl.). See Bot. Centralbl., xlii. (1890) p. 285.
‡ SB. Bot. Ver. München, Feb. 10, 1890. See Bot. Centralbl., xli. (1890) p. 374.
§ SB. Bot. Ver. München, Feb. 10, 1890 (14 figs.). See Bot. Centralbl., xli. (1890) pp. 378 and 405 (1 pl.).

hyphis decumbentibus, lanuginosis tomentosis v. sericeis, ramosissimis, septatis; sporocarpiis (oogoniis) pedicellatis, apicibus ramulorum innatis, corticatis. It is made up of the three genera *Physomyces*, *Helicosporangium*, and *Papulospora*, the first being thus characterized:—Sporocarpio polysporo, sporis liberis, hyphis numerosis rugoso-corticato.

Development of Pycnids.*—Sig. P. Baccarini classifies the pycnids of Fungi under two types—those with definite and those with indefinite development. The first type includes those forms in which the conceptacle is completely corticated, and is distinctly separated from the vegetative mycele. This includes the greater part of the Sphærioideæ; and the principal differences observed with regard to the development of this form of pycnid relate to the greater or less vigour of the nutritive pseudo-parenchyme, to the rapidity of its resorption, and to the mode of formation of the cavity, whether lysigenous or schizogenous. The second type comprises those forms in which the basidiogenous hyphæ maintain more or less connection during their activity with the vegetative mycele; the cortical investment is then incomplete, and is constantly interrupted at the base of the peridium, and the formation of a nutritive pseudo-parenchyme is greatly reduced, or almost entirely suppressed. To this type belong various forms of Nectrioideæ, Leptostromaceæ, and Melanconieæ.

Non-crystallizable Lichen-pigments.†—In 120 species of lichen examined, Herr E. Bachmann finds as many as sixteen different uncrystallizable pigments, viz. five green, one blue, four red, and six brown, of all of which the microchemical reactions are given. These all occur imbedded in the cell-membrane, a few others as drops in the interior or as excretions. They are not distributed uniformly through the thallus, but are limited to certain portions, almost always the cortex, very rarely penetrating to the medullary layer; the hyphæ of the gonidial layer are never coloured. In the hymenium the asci are never coloured, the paraphyses rarely. The colour of lichens is not unfrequently concealed by a coating of calcium oxalate. Within the membrane of the hyphæ, the pigment is always so distributed that the middle lamellæ contain a larger quantity of it than the inner ones.

The author has been unable to determine whether these pigments are formed from the activity of the protoplasm, or whether they arise in the cell-wall itself by metastasis. Their purpose appears to be to protect the organisms which contain them from unfavourable atmospheric conditions; the pigment itself and the calcium oxalate often associated with it also affording a protection against consumption by snails and caterpillars.

Spicaria verticillata.‡—M. C. Roumeguère states that in the neighbourhood of Toulouse the Chinese primroses, Clivias, and Begonias in the glass-houses are attacked by a mucedineous fungus, which appears to be *Spicaria verticillata* (Cord.) Harz. The hyphæ are simple at their base, but above are divided into 3–5 branches; the conids are oval and white, and measure $4 \cdot 5$ μ.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 150–14.
† Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 1–61 (1 pl. and 1 fig.).
‡ Rev. Mycol., xii. (1890) pp. 70–1.

Sphæropsideæ parasitic on Dianthus.*—M. C. A. J. A. Oudemans reduces all the species of Sphæropsideæ which are known as parasites on leaves of the European species of *Dianthus* to two—*Ascochyta Dianthi* Lib., and *Septoria Dianthi* Desm., regarding *Depazea Dianthi* Rab., *Phyllosticta Dianthi* West. and *Dimemasporium Dianthi* Oud. as synonyms of the former, and *Ascochyta Dianthi* Lasche and *Depazea Dianthi* Desm. as synonyms of the latter species.

Herpotrichia nigra.†—Dr. R. Raimann describes the injury inflicted on *Pinus Mughus* by this parasitic fungus belonging to the Trichosphæriaceæ. The favourable condition for its luxuriant development is excessive moisture, as, for example, when the branches are laden with snow. *Pinus excelsa*, though growing in the immediate neighbourhood, enjoys immunity from its attacks.

New Entyloma.‡—Under the name *Entyloma Ellisii*, Prof. B. D. Halsted describes a new species of this genus of parasitic fungi on the common spinach. It is the first species of *Entyloma* known to be parasitic on any plant belonging to the Chenopodiaceæ, and the first on any cultivated plant in America.

Hydnocystis.§—Herr P. Magnus assigns reasons for placing this genus of Fungi among the Pezizeæ, instead of among the Tuberaceæ, to which it has hitherto been considered to belong. He regards the Tuberaceæ as strictly cleistocarpous Ascomycetes, allied to the Perisporiaceæ, and especially to *Eurotium* and *Penicillium*.

New Parasitic Fungi.‖—M. C. A. J. A. Oudemans describes the following new Micromycetes:—Among Pyrenomycetes,—*Ophiobolus Jacobææ* on stems of *Senecio Jacobæa;* among Discomycetes,—*Phialea appendiculata*, on rotten stems of *Mentha aquatica;* among Sphæropsideæ,—*Sclerotiopsis Cheiri* on rotten stems of *Cheiranthus Cheiri*, *Ascochyta Solani* on dry stems of *Solanum tuberosum*, *Piggotia Gneti* on leaves of *Gnetum Gnemon;* among Hyphomycetes,—*Botrytis longibrachiata* on leaves of *Curcuma rubricaulis*, *Clonostachys Gneti* on leaves of *Gnetum Gnemon*, *Cercospora Violæ sylvaticæ* on leaves of *V. sylvatica*, *Stilbum sanguineum* on rotten leaves of *Gnetum Gnemon*, *Fusarium Caricis* on leaves of a species of *Carex*.

Dr. C. Massalongo ¶ gives descriptions of the following new species of parasitic fungi observed in the neighbourhood of Verona:—*Cylindrosporum Pimpinellæ* on *Pimpinella nigra*, *Phyllosticta astragalicola* on *Astragalus glycyphylloides*, *Ramularia Ballotæ* on *Ballota nigra*, *R. lamiicola* on *Lamium album*, *Stagonospora Iridis* on *Iris germanica*.

Dr. F. Cavara ** describes a new *Macrosporium* (*M. sarcinæforme*) which he found on red clover in the neighbourhood of Pavia. The parasite makes itself known by the presence of brown spots on the leaves.

* Med. K. Akad. Wetensch. Amsterdam, 1890, pp. 97–107 (1 pl.).
† Verhandl. K.K. Zool.-Bot. Gesell. Wien, xl. (1890) SB. pp. 10–1.
‡ Bull. Torrey Bot. Club, xvii. (1890) pp. 95–7.
§ Hedwigia, xxix. (1890) pp. 64–6.
‖ Med. K. Akad. Wetensch. Amsterdam, 1890, pp. 312–27 (2 pls.).
¶ Bot. Centralbl., xlii. (1890) pp. 385–7.
** 'La difesa dei parassiti,' 1890. See Rev. Mycol., xii. (1890) p. 148.

Prof. B. D. Halsted * describes a new species of *Zygodesmus*, a genus of fungi which is usually saprophytic, truly parasitic on a species of *Viola*.

British Hymenolichen.—Mr. C. H. Wright remarked at the April meeting of the Society:—"In Berkeley's Mycological Herbarium, now at Kew, there exists a plant collected at Coed Coch, North Wales, in 1866, which had been placed by Berkeley with *Stereum hirsutum* Fr., a fungus to which it bears a considerable amount of external resemblance, which is intensified by the latter being frequently infested by small algæ, e. g. *Chlorococcus*, &c. Upon microscopical examination this plant proves to be *Dictyonema sericeum* Mont. (*Dichonema sericeum* Fr.), a hymenolichen of frequent occurrence in the tropics of both hemispheres.

In 'English Botany,' Supplement, t. 2954, is figured a plant under the name of *Rhizonema interruptum* Thw., which, as Bornet † has suggested, is identical with *Dictyonema sericeum* Mont. This figure is repeated in Cooke's 'British Freshwater Algæ,' p. 266, t. 106, f. 2, where *Calothrix interrupta* Carm. is added as a synonym, with a note to the effect that 'we have seen no specimen of this.' Carmichael's specimen agrees perfectly with the 'English Botany' figure, as does also a specimen from Machynlleth (the original 'English Botany' locality) in Berkeley's herbarium. A similar specimen has been collected at Killarney. Both Carmichael and Hassall omit the colourless hyphæ in their figures, and class the plant as an alga.

The British localities for this species are:—Machynlleth (Ralfs)!; Coed Coch (Berkeley)!; Bristol; Wareham; Appin (Carmichael)!; Killarney!"

Chromogenic Pseudo-Yeasts.‡—Under the name "formes-levures" M. E. Laurent designates certain fungi which resemble true yeasts, but which are devoid of the fermentative faculty. In common with certain bacteria, these pseudo-yeasts possess the power of producing colouring matter. The oldest designation was *Saccharomyces glutinis*, a name which embraced many different kinds. They are extensively distributed in air and water, grow on boiled potato when exposed to air, and are much more frequent than *Micrococcus prodigiosus*, with which they may be easily confounded.

After recalling the fact that certain kinds of these organisms are found to produce a red, black, and violet pigment, the author narrates the life-history of a pseudo-yeast which developes a yellow colour. In most of its characteristics it was found to resemble *Dematium pullulans*, from which it only differs in its colour, its inability to liquefy gelatin, and in the fact that the older cells do not become embrowned. The author therefore considers this yellow pseudo-yeast to be a new variety of *Cladosporium herbarum*, a fungus remarkable for its polymorphism, and from which *Dematium pullulans* is descended.

Influence of Concentration of Nutritive Medium on Growth of Fungi.§—Herr P. Eschenhagen finds, from his experiments with various nutritive

* Bull. Torrey Bot. Club, xvii. (1890) pp. 151–2.
† Ann. Sci. Nat., ser. 5, xvii. p. 82.
‡ CR. Soc. Roy. Bot. Belgique, 1890, pp. 76–9.
§ Ber. Verhandl. R. Sächs. Gesell. Wiss., 1890, pp. 343–6.

media, that the growth of fungi therein diminishes according to the increasing concentration and finally ceases altogether. The fungi employed were *Aspergillus niger*, *Penicillium glaucum*, and *Botrytis cinerea*, all of which gave analogous results. These were grown on solutions of varying concentration of glucose, glycerin, nitrates of potash and soda, chlorine, &c. In the glucose experiments 0·6 per cent. of inorganic salts was added, and in the saline media 0·5 per cent. glycose was used as well.

Thrush-fungus.*—The thrush-fungus, says M. E. Laurent, has been classed as an *Oidium* and as a *Saccharomyces;* but it is neither a true *Oidium* nor is it an alcoholic ferment. The author cultivated specimens of thrush-fungus, obtained from hospitals in Paris and at Brussels. These cultivations presented sparsely septate filaments, 3–6 μ in diameter, commingled with pseudo-saccharomyces which were from 4·5–6 μ long, and 2·5–4 μ broad. In slightly acid saccharated liquids (sugared beer-wort), only the oval pseudo-yeasts were developed. They possessed no fermentative powers, and after the lapse of a month in a liquid containing 5 per cent. of sugar, only 0·6 per cent. of alcohol per volume was found. Hence they resemble the pseudo-yeasts of *Cladosporium herbarum* (*Dematium pullulans*). Another characteristic assimilates the thrush-fungus to the pseudo-yeasts. When cultivated on gelatinized beer-wort, it always developes quite dense spheroidal colonies, in connection with filaments from the ends of which they are propagated. In liquid media such colonies soon become free, and hence the connection between these and the filaments is not so apparent. Under no circumstances was the development of endospores observed. The author suggests that this fungus should be named *Dematium albicans*.

Himalayan Uredineæ.†—A second instalment of Dr. A. Barclay's monograph of the Uredineæ of the neighbourhood of Simla is devoted to the genus *Puccinia*. The following new species are described:—*P. Rosæ* on *Rosa macrophylla*, *P. Saxifragæ ciliatæ* on *Saxifraga ligulata* var. *ciliata*, *P. Roscoeæ* on *Roscoea alpina*, *P. Arundinellæ* on *Arundinella setosa* and *A. Wallichii*, *P. Anthistiriæ* on *Anthistiria anathera*, *P. Chrysopogi* on *Chrysopogon gryllus*, *P. Caricis filicinæ* on *Carex filicina*.

Dr. Barclay further describes ‡ the following three new species from the Simla region:—

(1) *Gymnosporangium Cunninghamianum*. The teleutospore-form occurs on *Cupressus torulosa*, the æcidium-form on the wild pear, *Pyrus Pashia*. The genetic connection between the two was determined by cultivation.

(2) *Puccinia Collettiana*, parasitic on *Rubia cordifolia;* spermogones, uredospores, and teleutospores; but no æcidiospores were detected. The author believes the spermogones not to be sexual organs, but the so-called spermatia to be a form of conid.

(3) *Chrysomyxa himalense*, parasitic on *Rhododendron arboreum*. The

* Bull. Soc. Belge de Microscopie, xvi. (1889–90) pp. 14–8 (2 figs.).

† Journ. Asiatic Soc. Bengal, lviii. (1889) pp. 232–51 (3 pls.). Cf. this Journal, 1889, p. 790.

‡ Scient. Mem. by Med. Officers Army of India, part v. (1890) 8 pp. and 3 pls., 5 pp. and 1 pl., 7 pp. and 2 pls.

author found presumptive evidence, but no experimental proof, of the genetic connection between this teleutospore-form and the æcidium on *Pinus excelsa*.

Trametes radiciperda.*—Dr. R. Hartig records the observation of the formation of conids in this hymenomycetous fungus. It takes place, however, only very rarely and with great difficulty, in artificial nutrient solutions.

Ceriomyces.†—M. J. de Seynes has investigated the structure of the fungus-forms included under the genus *Ceriomyces*, which are in fact the pycnids or endocarpous conidiiferous receptacles of species of *Polyporus*. Of the 1600 species of *Polyporus*, only about 10 are known in their *Ceriomyces* form; these all belong to the sections Mesopus, Pleurotus, Merisma, and Apus, none of them to the section Resupinati.

Development of Hypogæi.‡—Dr. R. Hesse recurs to the description of the motile rod-like bodies which he finds throughout the Hymenogastreæ, Tuberaceæ, and Elaphomycetes, and which he now terms "swarmers." In the presence of water these combine with one another and form compound swarmers, which, after coming to rest, unite into chains; from these is formed the mycele in all species of Hypogæi. The development of the ascospores of the Hypogæi is described in the case of *Balsamia fragiformis*. If the elliptical ascospores of this fungus are placed in a drop of water beneath the cover-glass, they are seen to be in a state of spontaneous motion, joining in pairs by their narrow rounded ends, separating, and again uniting in the same way with others. The spores have no cilia; but this proceeding gives the impression as if some substance passed out of one of the spores into the other. The whole of the mycele and receptacle of the Hypogæi is stated by the author to originate from structures which have a power of spontaneous motion.

The ascospores of this species present remarkable variations in size and form, and this is explained by the phenomena which accompany their conjugation. When two spores lie side by side, a gradual transfer of the contents of one of them into the other takes place; but this process may extend over several days. The product of conjugation is at first somewhat dumb-bell shaped, but finally oval or spherical.

Similar phenomena were observed in the ascospores of *Hydnocystis*, and in those of all other Tuberaceæ and Elaphomycetes examined.

Mycetozoa.

Development of Mycetozoa.§—Mr. A. Lister describes the mode of cultivation and life-history of several species of Mycetozoa, especially of *Chondrioderma difforme*, which was cultivated in several different ways, the most successful being by sowing the spores together with seeds of cress on moist blotting-paper. The spores of several species germinate

* SB. Bot. Verein München, March 10, 1890. See Bot Centralbl., xlii. (1890) pp. 109 and 136.

† Bull. Soc. Bot. France, xxxvi. (1890) pp. 109-12

‡ Bot. Centralbl., xli. (1890) pp. 196-8 (1 fig.); and xlii. (1890) pp. 1-4 (5 figs.). Cf. this Journal, *ante*, p. 77.

§ Ann. of Bot., iv. (1890) pp. 281-98 (1 pl.).

with great rapidity, even after having been kept more than a year in the cabinet. Ingestion of the food-material by the swarm-cells of *Perichæna corticalis* was observed similar to that already described in the case of *Stemonitis fusca*. The calcareous matter is discharged from the plasmode of *Chondrioderma difforme* immediately after it has taken the sporange-form.

Mr. Lister supports the view of De Bary that the Mycetozoa should be placed in the animal rather than in the vegetable kingdom. He considers it probable that many forms hitherto considered as distinct species will ultimately be traced to a common parentage; remarkable variation occurs in the progeny of a common parent, when the natural conditions are slightly altered by cultivation, in the structure of the calcareous wall of the sporange, in the degree of development of the capillitium (or even in its presence or absence), in the colour and size of the spores, and in the colour of the membranous wall of the sporange, of the threads of the capillitium, and of the plasmode. The colour of the plasmode is described in between 40 and 50 species.

Ingestion of Food-material by the Swarm-cells of Mycetozoa.*—Mr. A. Lister gives an account of observations on the ingestion of food-material by the swarm-cells of *Chondrioderma difforme*, *Physarum Tussilaginis*, *Stemonitis fusca*, and other Mycetozoa, the food-material being chiefly fragments of *Stereum hirsutum*, and the bacilli which accompany its decomposition. The bacilli become attached to delicate pseudopodes put out by the swarm-cells; the pseudopodes gradually contract and draw in the bacilli, which then become inclosed in vacuoles, where they are entirely absorbed, scarcely a trace of residuum remaining behind. Carmine was also greedily incorporated by the swarm-cells of *Stemonitis*, but not by those of *Amaurochæte;* the observation being thus opposed to that of De Bary, who states that the food is taken in during the swarm-cell condition only in a fluid state. The ingestion is frequently accompanied by a violent jerking movement of the swarm-cell. If inorganic matter was taken in, it was expelled after a longer or shorter period. The food-material appears to be taken in only at the posterior end of the swarm-cell, and the refuse matter discharged from the same region.

Protophyta.

α. Schizophyceæ.

Defensive Structure of Diatoms.†—Dr. D. Levi-Morenos asserts that the nutritive value of diatoms to fishes and other marine animals which feed upon them is not so much their protoplasmic contents as the mucilaginous envelope which covers them, many species passing uninjured and without being killed through the digestive tube. Their rapid passage is assisted by the fusiform and sinuous shape of many species of *Cymbella*, *Synedra*, *Nitzschia*, *Navicula*, *Pinnularia*, *Pleurosigma*, &c.

* Journ. Linn. Soc. (Bot.), xxv. (1890) pp. 435–41 (6 figs.). Cf. this Journal, 1888, p. 783.

† Boll. Soc. Ital. Microsc., i. (1890) pp. 103–18; and Notarisia, v. (1890) pp. 956–63.

Many of the larger species are also protected against being swallowed by the frustules being connected together into a pseudo-thallus, or by a large number being invested in a common gelatinous envelope. Since these characters are not constant in nearly allied species, it would appear as if they had been acquired at a comparatively late period for the purpose of protection.

Diatoms from New Zealand.*—Count Abbé F. Castracane describes a diatomaceous deposit from "Jackson's Paddock," Oamaru, New Zealand, in which he finds further evidence of the fact which he has already published—the formation of internal sporules. He also records the observation that in one of the species in this deposit the punctation of one of the frustules, in other words, the number of the granules, is determined from the first moment of existence of the diatom.

Diatoms in abundance.†—"The Golden Star Cleaning Powder," prepared at Keene, New Hampshire, and peddled about for the polishing of silver and plated ware, tin, glass, and other articles, is composed entirely of diatomaceous earth. The deposit is an exceedingly rich one, and the material seems to have been put through some process by which it has been partly cleaned, so that the diatoms are ready to be picked out, soaked in chloroform, and mounted. Many valves are broken, but there is abundance in a perfect state, some of them being well worth examining and preserving. Electro-silicon, a similar powder, sold for the same purpose, is also a diatomaceous earth, but of an entirely different character. The frustules included are usually small, disciform, and apparently all of one genus and species. Any one in need of diatoms is recommended to purchase a box of the "Golden Star Powder," when he will have more than he could look at if he should live to the age of Methuselah, and devote his whole time to their examination. The following recommendation from the N.H. State Assayer is worth noting; "The article you send is absolutely pure silica, of the kind known as polishing powder, formed by the decomposition of minute organisms supposed to be plants. Its great use is for polishing, but it is used for many other purposes."

'Le Diatomiste.'‡—We have received the first number of a new quarterly journal devoted to the interests of Diatomology, edited by M. J. Tempère, with the assistance of MM. Brun, Bergon, Cleve, Dutertre, Grove, and Peragallo. The present number contains descriptions of a number of new species with illustrative figures, an abstract of Mr. Rattray's synopsis of *Aulacodiscus* and *Auliscus*, published in this Journal, an index to the recently published numbers of Schmidt's 'Atlas de Diatomées,' together with a Bibliography and Correspondence.

Gelatinous sheath of the Oscillariaceæ.§—Under the name *Lyngbya Borziana* Prof. L. Macchiati describes a new species of this genus of Oscillariaceæ, distinguished by the fact that the hormogones sometimes consist of a single cell only. He takes the opportunity of expressing

* Atti Accad. Pontif. Nuov. Lincei, xliii. (1890) 12 pp.
† The Microscope, x. (1890) pp. 151–2.
‡ No. 1, June 1890, 4to, Paris (12 pp. and 2 pls.).
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 40–6. Cf. this Journal, 1888, p. 1012.

his agreement with Gomont,* rather than with Borzì, in sinking the genus *Lyngbya* in *Oscillaria*. The presence of a gelatinous sheath in species of the latter genus is so frequent that it cannot be relied on in distinguishing *Lyngbya* from *Oscillaria*. Kützing's genus *Phormidium* must also be reunited to *Oscillaria*.

The special colouring-matter of the Cyanophyceæ, phycocyanin, is soluble in water, but insoluble in alcohol or ether; it differs also from chlorophyll in not being acted upon by solar light; other micro-chemical reactions of this substance are given. The author does not agree with Borzì † that the straight hormogones are always destitute of a gelatinous sheath, those of *Lyngbya Borziana* frequently display one evidently. Microchemical reactions show that the gelatinous sheath of the Oscillariaceæ does not consist of cellulose or of protoplasm, but that it seems to have some relationship to the cutin of higher plants. The formation of spores appears to take place only at certain times of the year.

β. Schizomycetes.

Bacillus of Cholera in Soil.‡—Prof. V. de Giaxa draws the following conclusions from his experiments with the cholera bacillus on soil. When the cholera bacillus enters a soil rich in common bacteria, even though it find conditions favourable to its existence and reproduction, it rapidly succumbs in the struggle which takes place between itself and the other bacteria. The latter increase in number, and this increase is rendered possible as far as the deeper layers of the soil are concerned by the addition of nutrient material which agrees with them, and also modifies the condition of the ground.

Should the cholera bacillus enter in relatively large numbers a soil which is inhabited by few ordinary bacteria, not only its preservation, but also its reproduction become possible, until an increase of the common bacteria takes place from the penetration of the soil by nutritive matters which enter along with the pathogenic bacteria.

Germicidal action of Blood-serum and other Body Fluids.§—The doctrine of phagocytosis, invented by Metschnikoff, and claiming that bacteria are destroyed by certain cells (phagocytes), has been recently opposed by the conjecture that it is the fluid constituents of the blood which really furnish the destructive agent. Dr. T. M. Prudden has made experiments with two pathogenic bacteria, *B. typhosus* and *Staphylococcus pyogenes aureus*, on blood-serum and other body fluids. The experiments were conducted in the usual manner and with the usual precautions, and as the result thereof it was found "that fresh blood-serum possesses, though in different degrees in different animals, and in varying potency with the different bacterial species, a most marked germicidal power; that a similar germicidal power resides in fresh human non-inflammatory transudations. That this power is not directly associated with the formed elements of the blood or transudates,

* Cf. this Journal, 1889, p. 784.
† Cf. this Journal, 1887, p. 448.
‡ Annales de Micrographie, ii. (1890) pp. 222–51.
§ Medical Record, Jan. 25, 1890.

but is in some way dependent upon their albuminoid constitutents. It would furthermore appear that this singular and apparently most significant capacity of the body fluids is ultimately associated with that complex condition which we call life."

In conclusion, we may state that the author's paper is a most excellent summary of the present condition of this question, as well as a record of his own personal experience.

Bacteria of Milk.*—Professor H. W. Conn, in discussing the bacteria of milk, remarks that their function varies with the species, some of them having the property of imparting an agreeable flavour to the butter made from it, while others communicate a disagreeable odour and taste.

From milk and cream the author has isolated 40 different species, which, from their effects, are divisible into three classes:—(1) Some produce no visible effect, the milk remaining apparently unchanged. Some of these, however, render it slightly acid, others slightly alkaline, and nearly all produce certain decomposition odours. (2) Another series has the power of breaking up the milk-sugar, producing sufficient acid to curdle the milk. To this belongs *B. acidi lactici*. (3) A third class curdles milk, but the reaction is either alkaline, or the reaction is not affected. Such bacteria have the additional function of dissolving the curd which they produce, converting it slowly into peptones, whereby the milk becomes liquid again.

The author then proceeds to discuss the connection between butter and bacteria, the connection being established through cream, in which the growth is longer continued and more prolific. Now the action of bacteria on cream results in what is known as "ripening," by which butter "comes" more easily; secondly, it keeps longer; thirdly, the flavour is improved.

The ripening is effected by the action of bacteria which disintegrate the albumen, partly by production of an acid, and partly by a peptonization. The flavour is due to the impregnation of the butter with aromatic principles, the product of decomposition; the difference in taste and odour being due to the action of different bacterial ferments. Hence butter made from sweet cream is flat, insipid, and tasteless, because the bacteria have not had time or opportunity to produce the volatile decomposition products.

The author finally discusses the relation of milk-souring to electricity. From a series of experiments made on milk, he finds that electricity has not this effect on milk, and offers in explanation that "thunderstorms are usually preceded by climatic conditions of temperature and moisture very favourable to bacteria growth."

Spirobacillus gigas.†—M. A. Certes has found in the freshwater reservoirs at Aden a Spirillum which is remarkable in form and size.

In length it varies from 15–35 μ, and the width of the spirals is from 7–8 μ. In breadth the Spirillum does not exceed 1 μ. When alive or fixed by osmic acid, it resembles a spiral spring made of glass,

* 'Associated Dairying. Connecticut Board of Agriculture Report,' 1890, 43 pp.

† Bull. Soc. Zool. France, xiv. (1889) pp. 322–5 (8 figs.).

in which the spirals are very close together. The size of the individual varies with the number of spiral turns.

In some, spores which seemed black, or with bluish reflex, were observed. The sporiferous individuals were observed to possess a different method of locomotion to those which contained no spores. The former progress by a movement of rotation round their own axis; while the latter move backwards or forwards by means of vertical or horizontal undulations.

Under a 1/16 immersion no trace of internal organization is discoverable. Weak solutions of dahlia and methyl-blue fail to stain the Spirillum, but the spores become coloured violet or pale blue. The microbe is easily fixed by the vapour of osmic acid and by iodine solution. When mounted in Allen's or Farrant's media the microbe is quite life-like, and if dried it may be stained, like other micro-organisms, by anilin dyes, and then mounted in balsam.

This *Spirobacillus* appears at the expiration of three or four days in cultivations made with sterilized water and kept at a temperature of 20°–25°. For five days they multiply by fission, after which they disappear altogether. The author failed to revivify the spores left behind. But these cultivations were found to contain long straight mobile bacilli, especially characterized by the presence of two or four spores placed symmetrically at the extremities.

Flagella of the Cholera Microbe.*—It is not difficult, says Mr. G. F. Dowdeswell, provided that appropriate but quite ordinary means be adopted, to demonstrate the flagella of minute microbes, for example, the comma forms. The first to do this was Mr. E. M. Nelson, who showed them, in 1886, at a meeting of the Royal Microscopical Society. The optical apparatus required are a normal retina, a good objective with moderate angle of aperture, and a good light. For staining purposes gentian-violet answers as well as any other colour, but it is necessary to be particular as to the method of mounting. The specimens must be mounted in solution of acetate of potash, and not in balsam.

By this method no difficulty will be experienced in demonstrating flagella of microbes as small as *Bacterium termo*.

Resistance of the Cholera Vibrio to drying heat.†—The results of experiments with regard to the resistance offered by the cholera spirilla to desiccation and heat present two opposite conclusions, and it was to reconcile these antagonistic views, that Dr. S. Kitasato essayed further experiments to ascertain if the contradictory views might be explained by differences in the degree of resistance of cultivations, according as they are more or less old, or have been produced on different nutritive media.

With this intent the author steeped silk threads in cultivations, or spread a drop of them upon a slide. The threads and slides were dried, some over sulphuric acid, others in sterilized glass boxes; others were kept in moist heat as control experiments.

From hour to hour, threads and glasses were removed and sown in bouillon and gelatin. In order to ascertain the resistance of the different

* Annales de Micrographie, ii. (1890) pp. 377–9.
† Zeitschr. f. Hygiene, v. p. 136. Cf. Annales de Micrographie, ii. (1890) pp. 385–7.

cultures to heat, a droplet was mixed with liquid gelatin and kept at the desired temperature in a water-bath. The gelatin was afterwards made into Esmarch's plates.

From his experiments the author concludes:—(1) that there is no difference between young and old cultures, in respect to their resistance to heat and drying. (2) The length of time required to kill by desiccation depends on the way in which the material has been prepared, the silk threads being more resistant than the glass slides. (3) The nature of the cultivation exercises considerable influence, and threads dried over acid are more resistant than those dried in the air. (4) Different cultivations did not contribute any appreciable difference for temperatures between 50° and 60°. (5) The contradictions between authors relative to this resistance are easily explicable by the differences in the way in which desiccation has been effected; the more complete and rapid it has been, the more quickly the bacteria die.

Microbes of Hæmoglobinuria of Ox.*—This disease, says M. V. Babes, is an acute febrile disorder, endemic in certain marshy districts of Roumania, and is characterized by hæmoglobinuric urine and the presence of a microbe within the red corpuscles.

These microbes vary somewhat in appearance. In the living unstained condition they are seen as round pale spots about 1 μ in diameter, lying within the red corpuscles. When stained with a weak solution of violet B, they look like coloured globules $0 \cdot 5$–$1 \cdot 5$ μ in diameter, often with a division line across their centre, sometimes like the figure 8. In this living condition their outline is ill defined. When dried and stained they are smaller, while their contour becomes strictly defined and stains well.

Cultivations on artificial media produced colonies which showed under the Microscope cocci and diplococci, surrounded by a less colourable zone, this reproducing an appearance similar to that found in the blood. But the vitality and the pathogenic properties of the microbes developed artificially were soon lost.

From the author's remarks it is to be inferred, though it is not quite clear, that inoculation experiments were made, and that the symptoms of the disease and the suspected organism were reproduced.

Putrefaction Ptomaine obtained from cultivations of Bacterium Allii.†—The microbe, discovered by Mr. A. B. Griffiths, is from 5 to 7 μ long and $2 \cdot 5$ μ broad. It was found on rotten onions, upon which, as well as on gelatin, it produces a green pigment. This pigment, when dissolved in alcohol, gives an absorption band extending from the extreme violet to the blue, and also bands in the green and yellow. The end of the band in yellow is exactly in the same position as D in the solar spectrum.

Allowed to grow for several days on peptonized agar, *Bacterium Allii* produces a ptomaine, which was extracted by the methods of Gautier and Brieger. It is a white solid body soluble in hot water, alcohol, ether, and chloroform. It crystallizes in microscopic needles belonging to the prismatic system. These crystals are extremely deliquescent and have the odour of Mayflower, especially when heated.

* Comptes Rendus, cx. (1890) pp. 800–2. † T. c., pp. 416–8.

Analysis of its composition showed that its formula is $C_{10}H_{17}N$.

With regard to the origin of this alkaloid it cannot be doubted that it is a product of the chemical decomposition of the albuminoid molecules of the peptonized agar, produced during the life of *Bacterium Allii*.

Chromogenic Function of Bacillus pyocyaneus.*—Although, says M. C. Gessard, the earlier bacteriologists assumed that the hues produced by chromogenic bacteria were invariably and constantly associated with their vital activity, it now seems more probable that the presence of pigment represents a symptomatic reaction of the microbe which produced it, since the colouring matters obviously vary with the slightest differences in the cultivation medium and its environment. Hence it would be more in accord with our present knowledge to state the law thus:—The same microbe may present different biological and morphological characteristics, and identical morphological and biological characters may be found in different microbes.

This law is derivable from the colour appearances of the bacillus of blue pus, which is distinguished by producing a blue crystallizable pigment, pyocyanine. This blue pigment is easily recognizable on and isolable from dressings of wounds, but when *B. pyocyaneus* is cultivated in beef or veal broth, the pigment produced is not a pure blue, but a greenish blue, and is further marked by a certain degree of fluorescence. Both of these characteristics can be separately cultivated, the pigment in commercial peptone dissolved in 50 parts of water and the fluorescence in egg-albumen. A further characteristic of this fluorescence is that it is destroyed by addition of acid and increased by alkalies.

Hence the chromogenic function of *B. pyocyaneus* varies with the medium, and from these varieties the author deduces the law above stated.

Pathogenic Microbes in filtered water of the Rhone.†—MM. Lortet and Despeignes have found that, although the Rhone water when filtered contains only 7000 germs per litre, yet there passed through a Chamberland filter a considerable deposit consisting of organic and inorganic material remains.

In order to ascertain if this deposit from potable water reported to be of excellent quality, and in appearance perfectly filtered, contained pathogenic microbes in any considerable quantity, the authors inoculated guinea-pigs. Most of the animals died with suppurative visceral lesions, the organs most severely and most often affected being the liver and lungs.

These results indicate that this apparently good water is fraught with danger to the public health, and when the pressure on the filtering beds rises, as it must do whenever the river swells, this danger increases, since the deposit on the gravel is then detached, and thus becomes mixed up with the water distributed throughout a town.

Loss of virulence in cultivations of Bacillus anthracis.‡—From observations made on cultivations of *Bacillus anthracis*, M. S. Arloing concludes that in one cultivation the bacilli do not possess the same virulence nor the same vegetative potentiality. Senescence first shows itself in the

* Comptes Rendus, cx. (1890) pp. 418–20. † T. c., pp. 353–5.
‡ T. c., pp. 939–41.

feeblest bacilli, so that when a cultivation has been left to itself, the number of virulent and fertile organisms decreases.

At a given period a weak inoculation may not reveal any trace of virulence. Nevertheless, from the cultivation, quite a generation of virulent bacteria may be reared. But in order to bring this evidence to light, cultivation methods or strong inoculations must be employed.

Negative Indol-reaction as a test for the Typhoid Bacillus.*—The resemblance, from their morphological and cultivation aspects, of numerous bacilli to the bacillus of typhoid, suggests the importance of having some specific test which may be easily applied in making a differential diagnosis between the bacillus of typhoid and other bacteria.

Recent observations have shown that potato cultivations do not afford a certain criterion; but after experimenting with sixteen kinds of bacteria, Dr. S. Kitasato found that these, when cultivated in bouillon, produced indol, while the typhoid bacillus did not.

The indol was tested for by Salkowski's method, that is, by treating the cultivations with a solution of nitrite of potash, and then adding a few drops of strong sulphuric acid. With this test the typhoid bacillus remained colourless, while the other sixteen bacilli assumed the characteristic red hue.

Careful chemical analysis also constantly showed the absence of indol from the typhoid cultivations.

As all these pseudo-typhoid bacilli developed on potato quite differently from the real typhoid bacillus, the author concludes that the negative indol reaction is in itself no better test that the growth on potato is.

Canestrinis' Bacteriology.†—The 'Bacteriology' of G. and R. Canestrini is quite up to date on all branches of the subject. The general part of the work deals with the morphology and biology of micro-organisms, and also their mode of infection, while at the same time prophylaxis and hygienic precautions are not neglected. The various apparatus, cultivation, and staining methods as applied to the examination of water, air, and earth are clearly and precisely described. The special part deals with a number of micro-organisms pathogenic to man or the lower animals, and is very thorough.

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Compt. Rend. de la Soc. de Biol., 1890, No. 14, pp. 188–91.

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* Zeitschr. f. Hygiene, vii, No. 3. See Bot. Centralbl., xli. (1890) pp. 364–5.

† 'Batteriologia,' R. e G. Canestrini, 8vo, Milano (Hoepli), 1890, 29 pls. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 131–2.

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„ „ **Études sur l'immunité. III. Le charbon des rats blancs.** (Studies on immunity. III. Anthrax of white rats.) *Annales de l'Institut Pasteur*, IV. (1890) pp. 193–212.

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MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Altmann, R.—**Ueber die Verbesserungsfähigkeit der Mikroskope.** (On the possibilities of improvements in the Microscope.) Part II.
Arch. f. Anat. u. Physiol., Anat. Abtheil., 1889, H. 5, 6, p. 326.

Anderson, R. J.—**A panoramic arrangement for the Microscope.**
Internat. Monatsschr. f. Anat. u. Physiol., VI. (1889) H 8, p. 289.

Bernard, P.—**Note sur un Microscope composé du 18e siècle.** (Note on a compound Microscope of the 18th century.)
Journ. des Sci. Med. de Lille, XI. (1889), p. 1.

Heitzmann, C.—**Die Zukunft der Mikroskopie.** (The future of Microscopy.)
Wiener Med. Bl., XII. (1889) Nos. 37, 39.

Olivier, L.—**Histoire des Microscopes.** (History of Microscopes.)
La Nature, XVII. (1889) pp. 267, 314.

Poli, A.—**Le Microscope et sa théorie.** (The Microscope and its theory.)
Rev. de Bot., VII. p. 20.

(2) Eye-pieces and Objectives.

The Achromatic Object-glass.—J. Godfrey writes:†—"I am glad to find our correspondent 'Prismatique' coming to the front again, and as an amateur optician I write to ask his opinion upon a curious point. The glass I have always worked upon has been Chance's hard crown and dense flint, and after all sorts of experiments with different combinations of curves, I have found that a very good combination is to make the crown lens equiconvex, and the curves of the flint in the proportion of ten to one double concave. Of course I am well aware that these curves are foundation curves only, and that delicate and final corrections are indispensable; the workman, so I find, can only select curves to work up to, and alter, according to his experience and manual skill. Now I find—and this is the result, not of theory, but of experience—that with these proportions of the curves the flint lens corrects the achromatism of the crown slightly more at the marginal zone than it does at the centre. For example, if the flat lens so far over-corrects the crown as to eliminate the irrationality of the crown lens with respect to the red of the spectrum for the outside zone, there then remains, as I have found by practice, a minute residuum of the secondary spectrum in favour of the crown lens in the centre of the object-glass, a faint trace of red, which of course is not obtrusive, but it is there. Now I want to eliminate this want of balance between the outside and centre of the object-glass. At present I am very busy working upon two very fine and massive discs of Chance's hard crown and dense flint, and the object-glass will be 7 in. clear aperture; of course this is not the first glass I have made. My present 5 in. will show a curiously mottled and indented terminator upon Venus, and she is a terrible planet to define. Now I want 'Prismatique's' opinion upon this point. I propose to make my crown-lens equiconvex, 27·5 in. radius, and the focal length of the flint to be 49·6 in. This will give the proportions of the focal

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Engl. Mech., li. (1890) p. 118.

lengths 1:1·8, which I have found a good proportion. But now instead of putting the radii of the flint as 1 : 10, or nearly so, I propose to take a plano-concave and make the radius 24·8. Then I should work the back of the flint, not to an absolute curve, but to an exceedingly long concave curve, nearly a plane. This would necessitate the flint lens being fitted a short distance from the crown, about two-tenths or so by experiment, and I think that this would give a better correction for achromatism. I am quite aware that this would give a slight excess of spherical aberration to the concave; but, if necessary, I propose to correct it after fixing the distance between the lenses that will best suit the achromatism. Now, I am rather fortified in my belief that this modification will answer, in that my proposed construction will closely approximate to the construction of the object-glass of the Lick telescope, in which the convex is an equiconvex, and the flint is a double concave with a long concave curve at the back, and the two lenses are separated and are not in contact. It appears to me that the achromatism would be improved by separating the lenses."

The Jena Lenses.* — The following is part of a letter from "F.R.M.S.": †—As statements have been made in former numbers of this paper impugning the good faith of MM. Zeiss, as to the new objective of 1·6 N.A., I wrote them requesting an authoritative statement on the subject. They have very kindly sent me a copy of a letter which their Prof. Abbe has written to Mr. Mayall in consequence of my communication to them. Their letter is dated 10th September, and in it Prof. Abbe says :—" Please to take notice of a formal assertion from *my* part that the objective has *not* undergone any alteration whatever, while in Jena; *that every lens and every piece of the mounting was in exactly the same state at the second departure to London in which it was at the first departure.*"

The italics are the Professor's, not mine.

Prof. Abbe further states :—" Though I have not myself looked up the lens all the time over, I am in a position to give this assertion quite *positively* on these grounds.

"(1) Nobody in the workshop had any sensible interest in making an alteration and *concealing it to me.* For *nobody* except myself was responsible for whatever defect of the objective. The computations had been made under my personal direction, and I had approved of the optician's work after execution. If a defect of any kind had happened to come out afterwards, the fault would have been *mine only.*

"(2) Nobody *could* try to change or improve the system without consulting me, because no other person was *au fait* with regard to that particular construction."

Prof. Abbe further states:—" The objective had not been tried *photographically* by us, neither Van Heurck's sample, nor the other one. I was therefore *quite prepared to admit* that a 'chemical' focus could exist, owing to an insufficient approximation in uniting the violet ray with the other rays (in our computation) under the condition always that in Van Heurck's sample *the same defect must exist*, as both objec-

* Engl. Mech., Oct. 1890, p. 124.

† Published, however, without the authorization of Prof. Abbe.—Ed. J.R.M.S.

tives had shown the *same* degree of achromatism of the *visual* light. Though it appeared rather strange that Dr. Van Heurck should *not* have observed the fault, I supposed that he could perhaps have overlooked it, or had not found it hurtful, owing to his particular mode of illumination or photographic operation.

"In *this* spirit I advised Dr. Czapski to measure the residual difference of the chemical focus, and to compute a correcting lens, to be added to the system, in order to compensate for the expected difference.

"Having left the matter to Dr. Czapski, as I am not versed in photomicrography, I was *much astonished* to hear from him—a *short* time after arrival of the lens—that he could not find a difference of focus. In face of the positive assertion about the result of *your* trial, I felt doubtful about the accuracy of Dr. Czapski's observation, and I requested him decidedly *to repeat the trial* with all possible precautions, though *he* considered this as useless."

Fluor-spar at Oltscheren.*—Dr. E. v. Fellenberg gives a very full account of the occurrence at Oltscheren of fluor-spar, which is the subject of so much interest to microscopists at the present time. Fluorite is a mineral very widely distributed in the Alps. A locality long noted for the abundance of the pale-green variety is "Rann," or more correctly "Runn," a wood near Giesbach opposite to Brienz. The first mention of this locality is to be found in G. S. Gruner's 'Versuch eines Verzeichnisses der Mineralien des Schweizerlandes,' Bern, 1775, and a further description is given in Höpfner's 'Magazin für die Naturkunde Helvetiens,' vol. iv., 1789, in an account of a journey made by General-Commissioner Manuel in the Bernese Alps. Green fluor was also obtained in the Jura limestone from the Vordendürrschreunealp am Säntis and yellowish-brown and wine-coloured crystals from the Upper Jurassic limestone at Salève bei Genf. But by far the most remarkable and interesting occurrence of fluor is that at Oltscheren or Oltschialp, more exactly at Oltschikopf, south of the village of Brienzwyler in the Bernese Oberland. Here in 1830, according to a label on a specimen in the Bern Museum, Hans Fischer and Mitkaften discovered in a cleft of the mountain opposite Brienzwyler about 200 cwt. of fluor, of which 2 cwt. consisted of crystals. These men appear to have made considerable journeys with their treasure piled up in a cart in huge blocks, some of which, according to Prof. B. Studer, who purchased several specimens from them at the time, were a foot in diameter, and water-clear like blocks of ice. The precise locality of this remarkable find had been forgotten, when in 1886 Prof. Abbe began to make inquiries about the occurrence of water-clear fluor-spar. Many years before the author had sent to Herr Wappler, a mineral dealer in Freiberg, in exchange for Saxon minerals, some water-clear crystals of fluor from "das untere Haslithal im Kanton Bern." Prof. Abbe having seen these specimens was induced to visit the author, by whom he was referred to Herr Hamberger, the director of the pyrotechnic laboratory in Oberried, near Brienz, as well as to the hunter Caspar Blatter, as being the most likely persons from whom information could

* 'Ueber den Flusspath von Oltscherenalp,' Mittheil. Naturf. Ges. in Bern, 1889, pp. 202–19.

be obtained of the occurrence of fluor-spar of similar quality at Oltscheren. The crystal seekers, M. Ott and C. Streich, of Guttanen, as well as the hunter Caspar Blatter, were at once commissioned by Prof. Abbe to make investigations in the neighbourhood, but it was not until the spring of 1887 that they succeeded in rediscovering the old locality of 1830. A new locality was also discovered, from which beautiful green crystals, varying in size from 1 cm. in diameter to one over 20 cm. in length, were obtained. The surface of most of these specimens was rough, many being covered with irregular holes, while others looked like ice which had begun to melt in the sun. These specimens were offered for sale by Ott and Streich without the knowledge of Prof. Abbe, and were purchased by the authorities of the Bern Museum. Of the material sent to Prof. Abbe at Jena very little was found to be fit for optical use. The authorities of Brienzwyler now took action and prohibited further search for useful minerals in the district under their jurisdiction. An agreement was then drawn up by them with a company of capitalists, at whose head stood the firm of Zeiss, in Jena, and Prof. Abbe, by which the exclusive right of search for fluor-spar in that district was granted to the latter. The stipulation was, however, made that all material unfit for optical purposes should become the property of the authorities. The company began work in the summer of 1888 under the directorship of Herr Kable of Jena, who was stationed in a hut on the Alp Bühlen. According to a letter of Prof. Abbe to the author the old find of 1830 came from two cavities on the south part of the mountain. The lower one was easily accessible, but the other, high above, could only be reached by a 72 ft. ladder from another projecting rock mass. Both were found to have been exhausted, and further search for fluor in the neighbourhood only met with indifferent success as regards quality. In conclusion the author describes the visit he himself paid to the locality under the guidance of Caspar Blatter and Herr Kable. Starting from Meyringen with Blatter he passed by Prasti, Schüttelboden, Laui-Vorsass, and Platten to Bühlen, where Herr Kable was installed. With the latter he then proceeded through the valley of Oltscheren to the upper Alp Oberfeld, whence could be seen the south slope of the Oltschikopf, with the two cavities, from which came the extraordinary find of 1830, plainly visible.

JOHNSTON, C.—**The American Objective as compared with the German.**
Maryland Med. Journ., XXI. (1889) p. 130.

(3) Illuminating and other Apparatus.

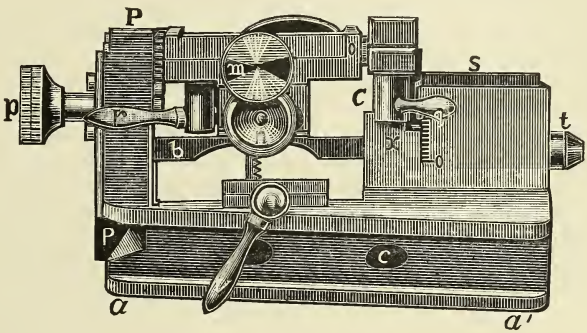
Object-carrier with Vertical Displacement for the Jung Microtome.*—Prof. L. Koch points out that the object-carrier hitherto used only allows a comparatively slight elevation (3 to 4 mm.) of the object adjusted. This is due to a great part of the slide-way being occupied by the micrometer screw and the object-carrier. In fact, for the object itself, the displacement is only about a millimetre, since often more than a millimetre of paraffin has first to be removed, and, if the course

* Bot. Centralbl., xl. (1889) pp. 283–5.

of the knife is very restricted, the full extent of the slide-way cannot be utilized. In most cases this small displacement is not sufficient, so that it is necessary to dismount the object during the work and readjust it. This entails loss of sections, irrespective of the inconvenience of such a process.

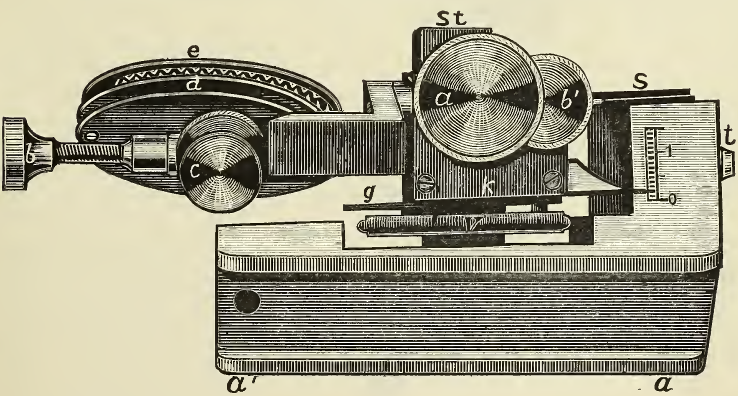
To get rid of this difficulty, Herr R. Jung of Heidelberg has, under the author's direction, constructed an object-carrier with vertical displacement. In one of these, represented in fig. 72, the frame O,

Fig. 72.



carrying the object-clamp, is movable in the vertical direction. This runs in a prismatic groove with so much friction that no fixing-arrangement is necessary to keep it in any given position. The

Fig. 73.



movement is effected by rack and pinion. The frame rests upon a steel base *b*, provided with a ratchet in which works a toothed wheel, set in motion by the lever *r*. One turn of the lever effects a rise of the frame, and consequently of the slide-way, of 1·2 cm.

To begin work, the lowest position is given to the frame carrying the object-clamp, the paraffin block is mounted somewhat high, and the

surface to be cut is raised, by means of the lever, up to the knife-edge. The removal of the paraffin is effected in the same way by means of the vertical displacement, but the cutting of the object itself is done exclusively by the use of the micrometer-screw. When the latter is turned to the end it is screwed back so as to bring the object-carrier into its original position, and the object is then again brought up to the knife-edge by means of the lever.

The object-carrier is especially serviceable in all cases in which the object is to be sectionized only at intervals determined by the development of lateral organs. The micrometer-screw is then used for the parts to be sectionized, and the vertical displacement for the rest. There is an index at x for measuring the intervals between two of the lateral organs to be cut. The object-carrier represented in fig. 73 is of simpler construction, but is quite satisfactory for most purposes, and is to be recommended for use with the small model of the microtome. The movable metal-piece k supports the projecting object-clamp, and runs in a prismatic groove *st*. It rests on a screw-plate V, by the rotation of which its rise and fall are effected. A binding-screw a fixes it in any position. The rise, exclusive of the slide-way, amounts to 1 cm.

New Heating Apparatus for Mineralogical Investigations.*—This piece of apparatus, designed by R. Brünnée, of the firm of Voigt and Hochgesang, in Göttingen, can be easily fitted to any Microscope. It serves to raise solid preparations or liquids to a high temperature. and, since the flame burns directly beneath the object-carrier, observation can be made by polarized light during the heating. The apparatus has the following arrangement:—Beneath the object-stage B (fig. 74) is a piece bored through in four places. Round the lower, conically turned, part of the piece the arm A is fitted. The latter is movable on the cone, and is fastened to B by a screw c. Between c and B a ring-shaped space o is left, which is contracted internally to a fine slit. The gas and air required for the flame stream through the tubes L and G (fig. 75) into this space. The object-carrier B is provided with a row of outlets L_1. The openings

Fig. 74.

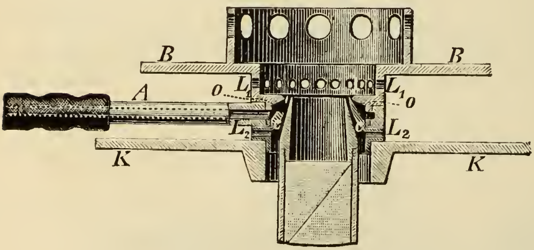
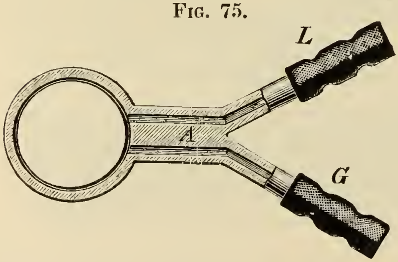


Fig. 75.

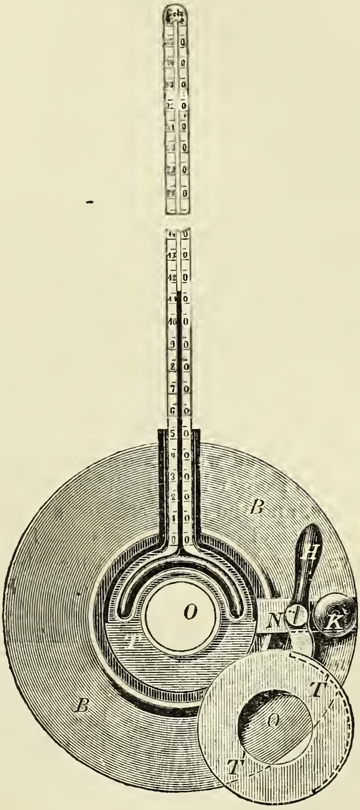


* Zeitschr. f. Instrumentenk., x. (1890) pp. 63–4.

L_2 are for the admission of air. The tube L of the arm A is in connection with a reservoir of compressed air, which effects a quick cooling when necessary.

To connect this apparatus with a Microscope, the lower part of the screw-piece fits into the aperture of the Microscope-stage, so that the stage can be rotated while the arm A with the tubes remains fixed.

Fig. 76.



For heating up to 360° a drum (fig. 76), which carries a thermometer and the preparation, is added to the apparatus. This consists of two parts T and T_1. The lower part T, carrying the thermometer, is connected with the stage B by a screw K, while the upper part T_1 can be turned to one side about the axis N by means of the lever H. The preparation is placed on a ring in the drum, and is kept at the same height as the thermometer.

The apparatus was exhibited at the Exhibition of the Heidelberg Naturforscher - Versammlung, and has been described in the 'Abtheilung für Instrumentenkunde.'* It has already met with considerable success and is particularly suitable for mineralogical-petrographical investigations.

Bolting Gauze.†—Mr. Charles M. Vorce writes that he has "done no microscopical work lately that has any novelty in it, unless it may be the measurement of an assortment of bolting gauze and other goods used for sieves, to ascertain the average and maximum sizes of the particles which pass through the same, and the relation of such size to the rating of the goods which is always by the number of meshes to the inch or centimeter. Bolting gauze of '200 meshes to the inch' will not pass particles of approximately globular form larger than about 1/400 in., and the *average* size of the particles passed will be considerably less, about 1/450."

A Simple Turn-table.‡—Mr. A. S. Elliott describes a simple turn-table. "Procure the frame and running gear of any cheap clock. Fifty cents will cover cost of all materials. Remove the main spring from its place and make the wheel carrying it firm on the shaft. Remove all

* Cf. Zeitschr. f. Instrumentenk., 1889, pp. 359 and 478.
† Amer. Mon. Micr. Journ., xi. (1890) p. 106. ‡ T. c., p. 117.

projecting parts from both top and bottom of frame. Reverse the centre wheel, putting the larger end of shaft uppermost, and making all bearings tight and smooth without oil. Cut a brass plate (soft) 3 inches in diameter; find centre, bore, then bore two more holes $1\frac{1}{4}$ in. from centre; make a pair of light bowed springs, solder to nail fitting such hole and fit tightly through plate, placing the clips in opposition to each other. Cut or scratch three concentric circles 1/4, 1/2, and 3/4, turning table rapidly. Fit the centre shaft firmly to plate without soldering.

The apparent disadvantage of using a cogged wheel in turning with the hand is more than counteracted by the greater ease and consequent steadier rotation, together with greater speed, attained by this table. Carefully made it will do as good or even better work than the ordinary form. If preferred the clips may be soldered fast to plate, but are rather unhandy.

The holes in the bottom of frame can be utilized to secure to firm base and hand-rest in any convenient manner to suit the requirement of the maker."

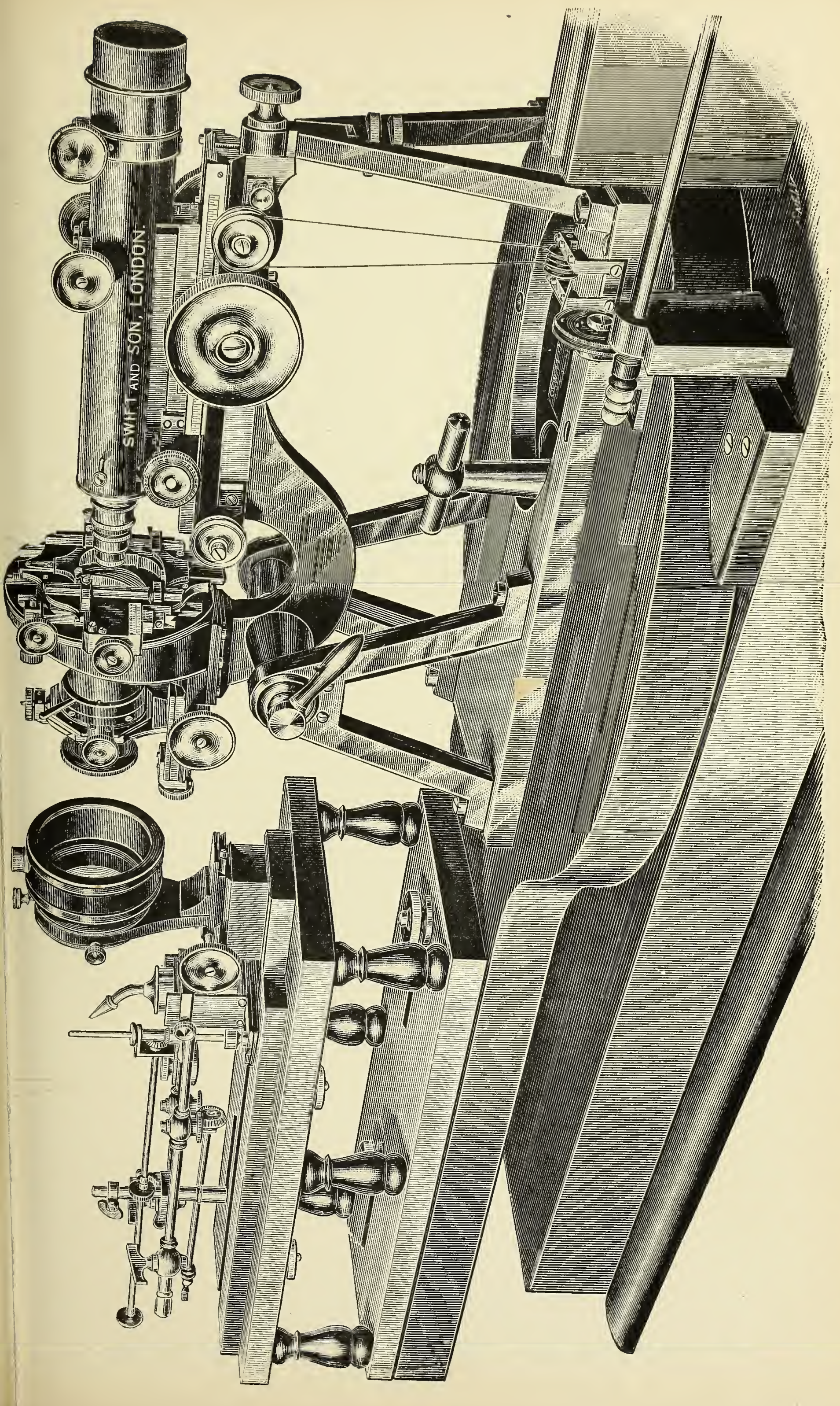
Cheap Boxes for Slides.*—Mr. Henry Shimer writes:—"W. P. Hamilton's slide-box described in the January number reminds me of a very nice arrangement. A box ready-made is more apt to be used than one made on purpose; for instance, the ordinary cigar-box, costing nothing. The flat ones are most suitable. They vary in size somewhat, but the ordinary one is about $4\frac{1}{2}$ by $8\frac{1}{2}$ by 2 in. inside. It can be filled with cardboard trays like Hamilton's, or with wooden ones made of cigar-boxes. The bottoms and lids will make bottoms for the trays, and the sides and ends sawn into narrow strips 1/8 or 1/4 in. wide and tacked on with brads, will make the margins. Each box will hold five trays. The bottom may be used instead of a tray by tacking a marginal strip on each end. Each of such boxes will store 70 short German slides, which by all odds are preferable, or it will hold 45 to 50 of the 3-in. slides. If we make the trays of cardboard, as per Hamilton, and a 3-in. holds 24, 2-in. holds 16 trays. Then 14 short slides to a tray gives room for 224 slides; 9 3-in. sheets to a tray gives 144 slides, or 7 to a tray will give 112 slides, and allow about 3/4 in. margin on the sides and a little less on the ends. Such boxes are neat, cheap, and convenient. The slides lie flat. These boxes can be numbered or otherwise labelled on the ends and stowed in bookcases."

BRAATZ, E.—**Ein neues Mikrotom.** (A new Microtome.)
Illustr. Monatsschr. d. Aerztl. Polytechn., XI. (1889) p. 159.
GARIEL.—**Chambre claire du Microscope.** (Camera lucida.)
Progrès Méd., VIII. (1888) No. 51.
PETTIGREW, J. B.—**On the use of the Camera Lucida.**
Trans. Manchester Micr. Soc., 1888, p. 80.

(4) Photomicrography.

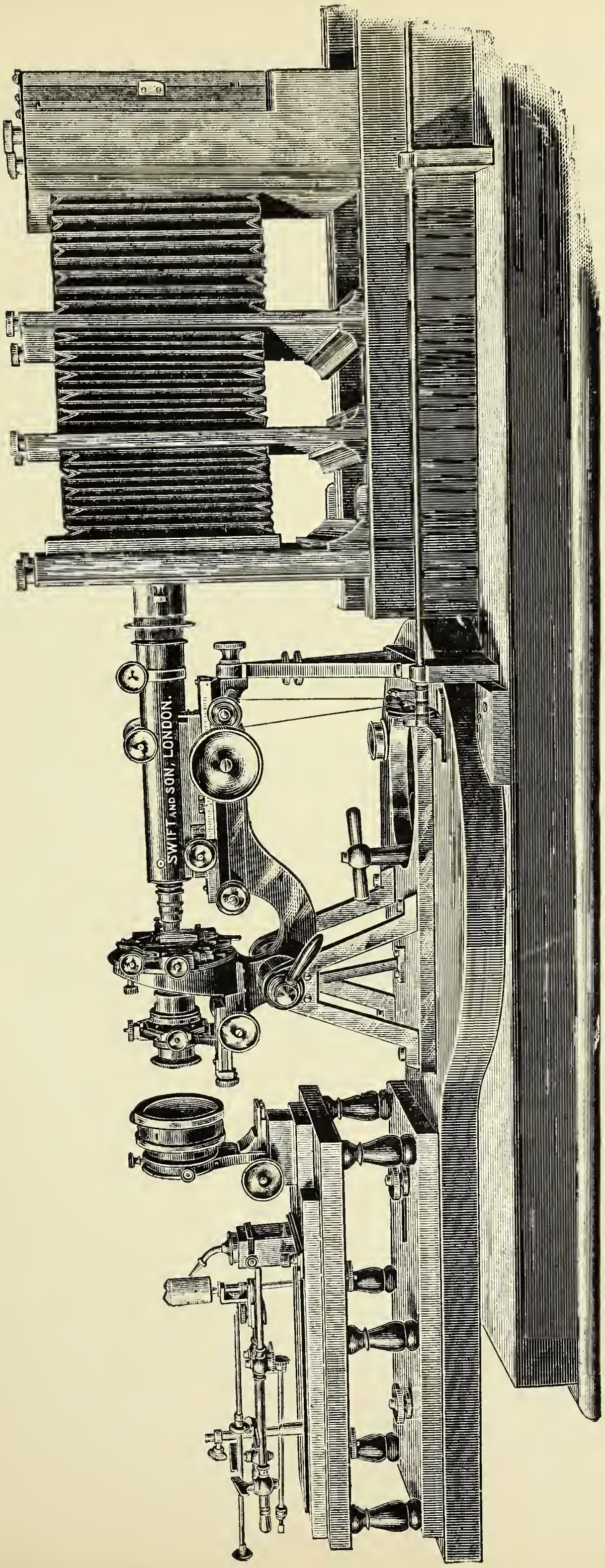
Mr. Pringle's Photomicrographic Apparatus.—The two figures now given (plates XII. and XIII.) will, without further comment, supplement the description of Mr. Pringle's photomicrographic apparatus which was given on p. 543 of the Journal.

* Amer. Mon. Micr. Journ., xi. (1890) p. 106.



Mr. Pringle's Photomicrographic Apparatus.

To face p. 666.



Mr. Pringle's Photomicrographic Apparatus.

To face p. 666.

Photomicrography by Gaslight.*—Major Geo. M. Sternberg observes:—Those who have had much experience in making photomicrographs will agree with me that one of the most essential elements of success is the use of a suitable source of illumination.

Without question the direct light of the sun reflected in a right line by the mirror of a heliostat is the most economical and in some respects the most satisfactory light that can be used. But we cannot command this light at all times and places, and it often happens that when we are ready to devote a day to making photomicrographs the sun is obscured by clouds, or the atmosphere is hazy. Indeed, in some latitudes and at certain seasons of the year a suitable day for the purpose is extremely rare. The use of sunlight also requires a room having a southern exposure and elevated above all surrounding buildings or other objects by which the direct rays of the sun would be intercepted. For these reasons a satisfactory artificial light is extremely desirable.

The oxy-hydrogen limelight, the magnesium light and the electric arc light have all been employed as a substitute for the light of the sun, and all give satisfactory results. I have myself made rather extensive use of the "limelight," and think it the best substitute for solar light with which I am familiar. But to use it continuously, day after day, is attended with considerable expense, and the frequent renewal of the supply of gas which it calls for is an inconvenience which one would gladly dispense with.

These considerations have led some microscopists to use an oil lamp as the source of illumination, and very satisfactory photomicrographs with comparatively high powers have been made with this cheap and convenient light. But in my experience the best illumination which I have been able to secure with an oil lamp has called for very long exposures when working with high powers, and as most of my photomicrographs of bacteria are made with an amplification of 1000 diameters, I require a more powerful illumination than I have been able to secure in this way. And especially so because of the fact that a coloured screen must be interposed, which shuts off a large portion of the actinic rays, on account of the staining agents usually employed in making my mounts. The most satisfactory staining agents for the bacteria are an aqueous solution of fuchsin, or of methyline-blue, or of gentian-violet, and all of these colours are so nearly transparent for the actinic rays at the violet end of the spectrum that a satisfactory photographic contrast cannot be obtained unless we shut off these rays by a colour screen.

I am in the habit of using a yellow screen for my preparations stained with fuchsin or methylen-blue, and have obtained very satisfactory results with the orthochromatic plates manufactured by Carbutt of Philadelphia, and a glass screen coated with a solution of tropoline dissolved in gelatin.

But with such a screen, which shuts off a large portion of the actinic light and increases the time of exposure three or fourfold, the use of an oil lamp becomes impracticable, with high powers, on account of the feebleness of the illumination.

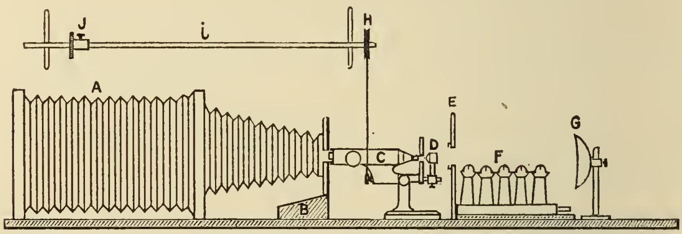
These considerations have led me to experiment with gaslight, and

* John Hopkins University Circulars, ix. (1890) p. 72.

the simple form of apparatus which I am about to describe is the result of these experiments. I have now had the apparatus in use for several months, during which time I have made a large number of very satisfactory photomicrographs of bacteria from fuchsin-stained preparations with an amplification of 1000 diameters. My photographs have been made with the 3 mm. ol. im. apochromatic objective of Zeiss and his projection eye-piece No. 3. I use a large Powell and Lealand stand, upon the substage of which I have fitted an Abbe condenser. The arrangement of the apparatus will be readily understood by reference to the accompanying figure.

A is the camera which has a pyramidal bellows front supported by the heavy block of wood B; this can be pushed back upon the base-board which supports it so as to allow the operator to place

Fig. 77.



his eye at the eye-piece of the Microscope. When it is brought forward an aperture of the proper size admits the outer extremity of the eye-piece and shuts off all light except that coming through the objective. C is the Microscope and D the Abbe condenser supported upon the substage; E is a thick asbestos screen for protecting the Microscope from the heat given off by the battery of gas-burners F. This asbestos screen has an aperture of proper dimensions to admit the light to the condenser D. The gas-burners are arranged in a series with the flat portion of the flame facing the aperture in the asbestos screen E. The concave metallic mirror G is properly placed to reflect the light in the desired direction. I have not found any advantage in the use of a condensing lens other than the Abbe condenser upon the substage of the Microscope. The focusing is accomplished by means of the rod *i*, which carries at one extremity a grooved wheel H, which is connected with the fine-adjustment screw of the Microscope by means of a cord.

The focusing wheel J may be slipped along the rod *i* to any desired position, and is retained in place by a set-screw. The rod *i* is supported above the camera by arms depending from the ceiling, or by upright arms attached to the base-board.

I have lost many plates from a derangement of the focal adjustment resulting from vibrations caused by the passing of loaded waggons in the street adjoining the laboratory in which I work. This has been overcome to a great degree by placing soft rubber cushions under the whole apparatus.

Position of the Light-filter in Photomicrography.*—Since 1866 it has been the generally received doctrine, says Dr. R. Neuhauss, that the position of the filter for producing monochromatic light is of the greatest importance. This doctrine, laid down by Moitessier and followed by all other writers, states that the maximum of absorption is attained when the filter is placed before the collecting lens, and its minimum when inserted between the lens and its focus.

By experiments with a yellow disc placed in the position of the object on the stage and using an ordinary non-orthochromatic silver-bromide-gelatin dry plate covered with a silk-paper sensitometer in the one case, and inserting the yellow disc between the light and the lens in the other, it was found that the two images were exactly alike in every respect. For both the exposure was exactly 15 minutes, and in both negatives the numbers could be read when the layers of silk paper were not more than sixteen.

Similar results ensued from using a layer of a saturated solution of picric acid 3 mm. thick. Hence it is quite indifferent whether the filter be placed near the lens or its focus.

(6) Miscellaneous.

The Microscope in Geology.—A course of twelve lectures on the Microscope in Geology (with special reference to the structure and origin of the stratified rocks), is now being delivered by Professor H. Alleyne Nicholson in the British Museum (Natural History), Cromwell Road, on Mondays, Wednesdays, and Fridays, at 3 p.m., beginning 6th October and ending 31st October, 1890. Admission to the course is free.

β. Technique.†

(1) Collecting Objects, including Culture Processes.

Cotton-wool as a substitute for Silk in Bacteriological Work.‡—Dr. E. Braatz finds that animal products have a much greater affinity for mercury than vegetable, and for this reason advises that cotton-wool threads be used instead of silk threads in bacteriological work.

Effect of highly concentrated Media on Bacteria.§—Prof. H. Buchner replies to Metschnikoff's assertion that the inhibitive influence of the body fluids on micro-organisms is to be ascribed to the greater concentration of these fluids. The author first remarks that the germicidal property of serum is quite extinguished by heating it to 55° for half an hour, although its degree of concentration remains quite unchanged. He then gives the results of experiments made with highly concentrated media, viz. blood charged with 23 per cent., and also with 40 per cent. of cane sugar. In both instances, although there was at the very

* Zeitsch. f. Wiss. Mikr., vii. (1890) pp. 20-2.

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

‡ Centralbl. f. Bakteriol. u Parasitenk., viii. (1890) pp. 8-9.

§ T. c., pp. 65-9.

outset a slight diminution of the Bacteria, they soon grew well enough.

Other two sets of experiments were made with 10 per cent. sugar and 10 per cent. pepton, each mixed with 10 volumes of blood. Both of these series as compared with a control series without sugar, showed that the addition made practically no difference.

Hence it is obvious that neither the concentration of the medium nor the too sudden transition of the Bacteria to an unaccustomed medium makes any difference to the result.

(2) Preparing Objects.

Method of Preparing Mucous Gland of Prosobranch Molluscs.*— M. F. Bernard found difficulty in obtaining reagents which were not either unable to coagulate the mucus or which were not too energetic, and so disformed the cells. He found, however, three mixtures which acted well, part of the gland being removed from the mantle as rapidly as possible. These were strongly acidulated picro-sulphuric acid; chloride of ruthenium of such strength that the solution is a clear red colour; this was the best of the reagents employed, but unfortunately the author was not able to get as much of it as he wished; it greatly aids dissociation with needles. The third mixture was made of 200 grammes of distilled water, 10 of alcohol at 90 per cent., 5 of glycerin, and 10 of acetic acid; this solution facilitates the staining of the elements with methylen-blue. Fragments thus fixed were teased in 38 per cent. alcohol, osmic acid at 1/10,000, or the acid mixture just mentioned. The last gave particularly good results with animals from Naples which had been already fixed by alcohol or various other reagents.

Mounting Insect Eggs to study the Embryo.†— Mr. E. A. Hill describes a method devised by himself, which he has used for two or three years past, in collecting and preparing the eggs of Lepidoptera for the microscopic examination of the embryo in its various stages of development.

In summer evenings, when working with the Microscope, the window being open, as is usually the case, moths frequently fly in attracted by the light; and when pursuing this line of investigation Mr. Hill has on hand a number of pasteboard pill-boxes (size is not important, but some which happened to be at hand were about 1 in. deep, and 3/4 in. in diameter). The moths are easily captured, after which each is placed in a separate box, with a reference letter on the cover. The next morning a number will usually be found to have laid eggs. These eggs are divided into as many equal parts as he anticipates there are days in the period of incubation, placing each portion in a separate homœopathic phial, the phials being about 1 in. high. The corks are marked with the reference letter entered in the record book, and, in addition, the phials are numbered consecutively from 1 upwards. The corks are inserted lightly, so as to allow air to enter the phials. Phial No. 1 is then filled at once with carbolic acid, filling No. 2 on the second morning, No. 3 on the third morning, and on the last day filling the phial containing the newly

* Ann. Sci. Nat., ix. (1890) pp. 305–6.
† The Microscope, x. (1890) pp. 208–10.

hatched larvæ, entering in the note-book the time required for hatching. Meanwhile, if it is desired, and this is the better plan, the moth is mounted after the usual manner of entomologists, on an entomological pin, and preserved in a cabinet with the same reference letter, so that the species can be determined at leisure. The carbolic acid renders the eggs perfectly transparent, or at least does so in the cases which have come under notice, and hence the embryos can be observed in the various stages of development. Mr. Hill mounts in benzol-balsam direct from the carbolic acid, and to prevent the crushing of the eggs sometimes uses three supports for the cover-glass placed triangularly between it and the slide. Three are better than four, as three points afford a more uniform bearing for the cover than four, on the well-known principle of the three-legged stool.

For the supports either small beads are used, or, if special thicknesses are required for the supports, they can be made by drawing out a fine thread from a piece of glass tube by means of a spirit-lamp, after which small pieces can readily be broken off. Tin-foil also makes good supports. For example, cut a strip about 1 in. square, and roll it into a tight roll 1 in. long; it should then be flattened between two glass slides to a uniform thickness, when little square pieces can be readily clipped off with a pair of scissors and used instead of the beads. The thickness of the roll can be varied, and the little squares can also be reduced in thickness by removing one or more layers of the tin-foil until of the proper size.

Theoretically, a series of eggs beginning with No. 1 and running up consecutively should show a progressive development of the embryo, but practically there is not always as much regularity in the series as we could look for. Probably the eggs first laid develope first, and twelve hours' difference in the time of laying the first and last egg, if the whole period of incubation only amounts to a few days, may make some difference. When, however, we have several eggs in each phial, no trouble will usually be experienced in getting a good progressive series by making a judicious selection from each bottle, in which case the selected specimens may be mounted in proper order on a single slide.

Preparation of Eyes of Lobsters.*—Mr. G. H. Parker describes a method of staining nerve-fibres which he discovered while experimenting with Weigert's hæmatoxylin. The method consists in a cautious use of Schällibaum's fixative; the one employed consisted of three parts of oil of cloves, and one part of Squibb's flexible collodion; the mixture should be allowed to stand a week before being used. A moderate amount is applied to the slide, and the sections in paraffin are placed on it; the slide and the sections are now subjected to a temperature of 58° C. for fifteen minutes, and this is a point which must be carefully attended to. The slide must next, while warm, be thoroughly washed with flowing turpentine, which can be conveniently applied from a small wash-bottle; all the paraffin should be removed from the slide before it becomes cool. When the slide is cool the turpentine may safely be replaced by alcohol, 95 per cent., then 70 per cent, 50 per cent., and

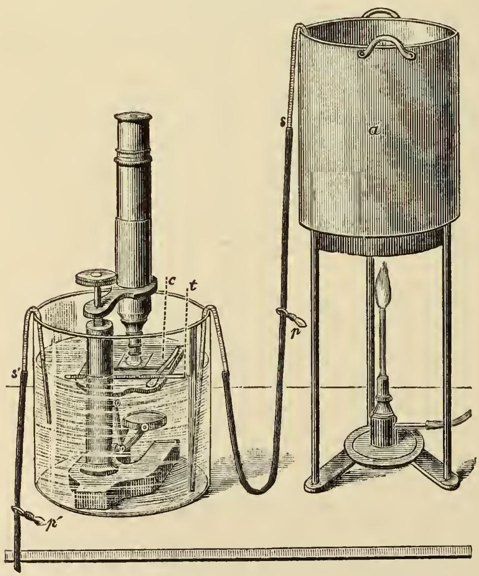
* Bull. Mus. Comp. Zool., xx. (1890) pp. 3-4.

35 per cent., and finally it may be immersed in water. Sections of optic nerve mounted on slides and carried into water must be treated for about half a minute with an aqueous solution of potassic hydrate (1/10 per cent.), then thoroughly washed in distilled water, and transferred to Weigert's hæmatoxylin, in which they should remain for about three hours at 50° C. After distilled water and grades of alcohol they may be cleared in turpentine and mounted in benzol-balsam. Each nerve-fibre so treated has a distinct blue-grey outline.

Methods of Recognizing Cysticerci of Tænia saginata.*—M. A. Laboulbène has a note on the means of recognizing the cysticerci of *Tænia saginata*, which are the cause of "measles" in veal and beef, and which are often so difficult to detect on account of the rapidity with which they dry on exposure to the air. He finds that meat which has become quite leathery will easily reveal the *Cysticerci* if it contain any, by being placed in water acidified with acetic or nitric acids, or in a mixture of water, glycerin, and acetic acid. By this means the parasites can always be detected, and if the meat be carefully heated to 50° or 60° C. it is always fit for human food.

New Method for Examining microscopically the Elements and Tissues of Warm-blooded Animals at their physiological temperature.†—This method, devised by M. L. Ranvier, essentially consists in placing both the Microscope and the preparation to be examined in a bath of warm water (36° to 39° C.) But like most practical things the details are more important than the principle. Thus the Microscope must be of a simple model. As the preparation is to be examined under water an immersion objective with or without correction must be used. The preparation must be carefully protected from water by running paraffin round the cover-glass. Before using the objective it must be warmed up to 40° C., otherwise a thick fog will spread over the face of the lens. The Microscope is placed in a flat-bottomed glass vessel about 0·12 m. high and 0·14 m. in diameter. This contains *distilled* water, heated up to 40°, in such quantity that its surface is from 0·5–1 cm.

Fig. 78.



* Comptes Rendus, cxi. (1890) pp. 155–7. † Op. c., cx. (1890) pp. 66–9 (1 fig.).

above the level of the stage. A thermometer placed by the side of the preparation indicates the temperature of the latter.

The most convenient temperature for observations ranges from 37°–38°, and if observations are to be maintained longer than eight or ten minutes it is necessary not only to add warm water, but to remove the surplus in order that the original level may be maintained. This can be effected as in the illustration by means of two siphons, or by placing the glass vessel within one which is larger but not so high.

By means of this apparatus the author states that he has made more observations in a month than in the past twenty years with the old arrangements.

Microchemical Tests for Alkaloids and Proteids.*—M. L. Errera points out the want of a general test for the discrimination of alkaloids and proteinaceous substances. Although many alkaloids are readily detected by special reactions, yet Raspail's proteid-reaction (a red colour produced by sugar and sulphuric acid), and Millon's reaction, are both also produced by certain alkaloids. The best general distinctive tests for these two classes of substances are their different behaviour towards (*a*) absolute alcohol, (*b*) one gr. of tartaric acid in 20 ccm. of absolute alcohol, (*c*) 0·2 ccm. of hydrochloric acid in 5 ccm. of distilled water and 95 ccm. of absolute alcohol. In these three reagents all alkaloids are readily soluble, while proteinaceous substances are either entirely insoluble, or at all events leave a residue behind, even after very long treatment.

Reactions for Lignin.†—Herr R. Hegler discusses in great detail the various reagents used for the micro-chemical detection of lignified membranes. He divides those already in use into three groups, viz.:—(1) Those which react with vanillin, but not with coniferin,—thallin; (2) Those which react with coniferin but not with vanillin,—phenol-hydrochloric acid, thymol-hydrochloric acid; (3) Those which react with both vanillin and coniferin,—all the other reagents for lignin. Thallin, $C_9H_6NOCH_3H_4$, is an extraordinarily delicate reagent for lignified tissues, the vanillin assuming an intense orange-red colour. A new reagent recommended, with the same properties, is toluilendiamin, $C_6H_3(CH_3)(NH_2)_2$, used in a concentrated aqueous solution with a trace of hydrochloric acid; it stains lignified membranes a dark orange. Vanillin he regards as a product formed out of coniferin by the activity of the protoplasm; the process being of the nature of fermentation with secondary oxidation. The production of lignin, $C_{18}H_{24}O_{10}$, out of cellulose may be represented by some such equation as this:—$4C_6H_{10}O_5 = C_{18}H_{24}O_{10} + C_6H_6O_5 + 5H_2O$; the $C_6H_6O_5$ may then be completely oxidized into carbon dioxide and water, or may pass over into such substances as tannins.

Fixing and Staining of Leucoplasts and Protein-crystalloids.‡—Dr. A. Zimmermann recommends a concentrated alcoholic solution of

* 'Sur la distinction microchimique d. alcaloïdes et d. matières protéiques,' Bruxelles, 1889. See Bot. Ztg., xlviii. (1890) p. 232.

† Flora, lxxiii. (1890) pp. 31–61 (1 pl.). Cf. this Journal, 1889, p. 606.

‡ Beitr. z. Morph. u. Physiol. d. Pflanzenzelle, Heft 1, 79 pp. and 2 pls., Tübingen, 1890. Cf. *supra*, p. 617.

corrosive sublimate for fixing the leucoplasts, e. g. in the epidermal cells of the leaves of *Tradescantia discolor;* the leucosomes themselves not being in any way changed by the sublimate. Good results were also obtained—though not so good—with concentrated alcoholic solution of picric acid, and with alcohol alone. With small pieces this immersion in the sublimate solution is sufficient. To prepare for the microtome they should then be placed first in pure alcohol, then for twenty-four hours in a mixture of three parts xylol and one part alcohol, then as long in pure xylol, then in a solution of paraffin in xylol saturated in the cold, finally in pure paraffin. For staining, Altmann's method * with acid-fuchsin was found to be the best; but a special modification of it is described in detail. Iod-green, cyanosin, and dahlia may also be used.

For fixing the cell-granules the author uses either a concentrated alcoholic solution of picric acid or 3 per cent. nitric acid. They may then be stained with acid-fuchsin by Altmann's method, which colours the granules an intense red, while the chloroplasts and nucleus are left quite colourless.

For staining the proteid-crystalloids, a method is employed termed by the author the acid-fuchsin method B. The section is first of all dehydrated by alcohol, and then placed in xylol or in xylol-Canada-balsam. The leucoplasts are fixed by picric acid or sublimate, and the section then stained with acid-fuchsin. While the nuclei and nucleoli remain perfectly uncoloured, the crystalloids take up an intense red. Good results were also obtained by the ordinary Altmann's acid-fuchsin method; also by fixing with concentrated aqueous or alcoholic solution of sublimate, aqueous or alcoholic solution of picric acid, 5 per cent. solution of potassium bichromate, or with Müller's fluid.

(3) Cutting, including Imbedding and Microtomes.

Imbedding Vegetable Preparations in Paraffin.†—Herr L. Koch discusses at great length and with copious detail the proper method of imbedding vegetable preparations in paraffin. After a critical survey of various methods of paraffin imbedding, the author gives a general outline of his views on the subject, and then proceeds to give the minutiæ requisite for obtaining a satisfactory result in special cases. His views, however, are tolerably simple, and do not seem to differ materially in practice from those of other people who apply themselves to vegetable anatomy.

The general proposition, on which much stress is laid, and the obvious inference therefrom, is one which occurs to any person after a very small amount of practice. It is that the imbedding mass must be made to penetrate into cells and intercellular spaces, and in order to do this the air and water must be thoroughly and completely removed. This is effected by immersing the objects in spirit, the strength of which is gradually increased up to absolute alcohol. The objects are then saturated with paraffin dissolved in chloroform. The saturation is effected by gradually increasing the thickness of the paraffin mixture; when a

* Cf. this Journal, 1888, p. 147.

† Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 367–468.

suitable consistence is attained, the block is cut up with a medium sized Jung's microtome. The description of this well-known section-cutter seems somewhat superfluous. The sections, which vary from 0·03 to 0·005 mm., are fixed to the slide with the collodion and clove oil mixture and the paraffin dissolved out with turpentine. The turpentine is dissolved out effectually with alcohol, and this in its turn with water. The specimens are then mounted in glycerin or Kaiser's glycerin jelly. Staining and mounting in balsam are passed over in a very few words.

(4) Staining and Injecting.

Laboratory Notes.*—Mlle. Leclerq points out that it is advantageous to stain sections so as to show the micro-organism and the tissues as well. This can be effected by first staining with borax-carmine, and then using Gram's or Bizzozero's method. The steps to be followed are, first stain the section with borax-carmine, followed or not by decoloration with hydrochloric acid according to the result that is desired; washing in water; staining with Ehrlich violet; washing in absolute alcohol followed by the Lugol iodine solution; washing in absolute alcohol followed by decoloration in 1 per cent. chromic acid; then absolute alcohol, oil of cloves, and balsam.

For staining embryonic blood-corpuscles of birds, so as to distinguish them from other embryonic elements, the authoress gives the following method:—(1) Overstain with fuchsin; (2) moderate decoloration with 1/3 to 1/5 aqueous solution of acetic acid; (3) washing in water; (4) rapid staining with weak solution of malachite green; (5) dehydration in absolute alcohol; (6) clearing up in oil of cloves or origanum oil according to the degree of staining; (7) mounting in balsam.

By this method the malachite-green combines with the fuchsin in the embryonic tissues, which become violet-coloured, while the blood-corpuscles and the karyokinetic figures are red.

The foregoing, although good for birds, is not successful for mammals, and for these the authoress adopts a method of triple staining, wherein she uses Congo red. This method consists (1) in staining for 10–15 minutes in a very weak solution of Congo red; (2) washing in water; (3) staining with Ehrlich's violet, followed by decoloration according to Gram's or Bizzozero's method; (4) staining with alcoholic eosin; (5) Dehydration in absolute alcohol, then oil of cloves and balsam.

In this case the blood-globules are stained an orange-yellow.

Apparatus for Impregnating Tissues, &c., and for making Esmarch Tubes.†—Dr. M. Herman describes an apparatus which is serviceable for histological, pathological, zoological, and bacteriological purposes. It consists of a water-wheel R (fig. 79) which revolves in a box. On one side of its axis is the handle M, and on the opposite side is an open metal case D, the latter being for the reception of a test-tube T, which is intended for the Esmarch cultivation method. The box rests on the

* Bull. Soc. Belge Micr., xvi. (1890) pp. 61–5.

† Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 55–7 (2 figs.).

plate S, and this can be moved up and down by means of the screw V. The hopper E is divided into two compartments *a* and *b*, so that the water, which is introduced into the hopper through a pipe, may pass

Fig. 79.

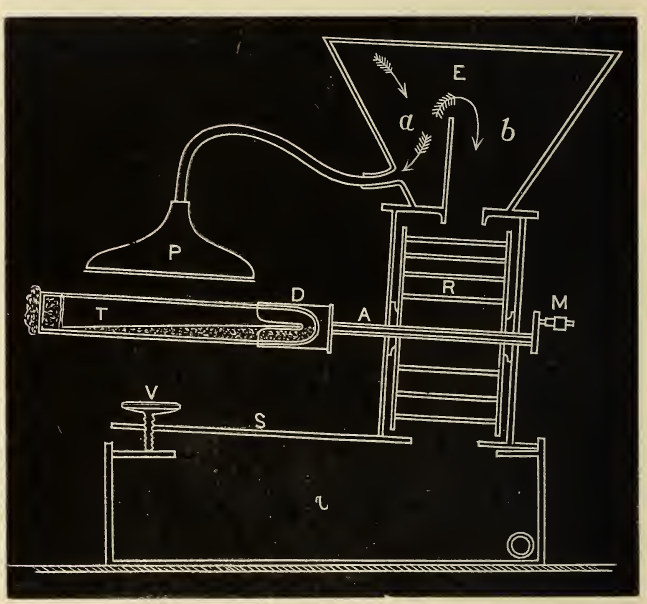
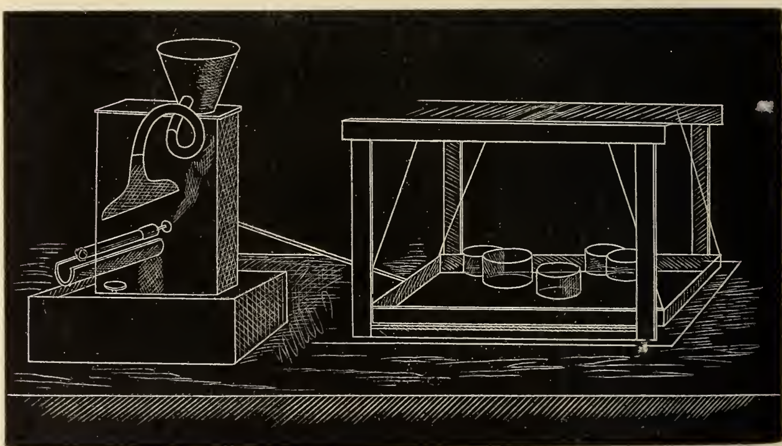


Fig. 80.



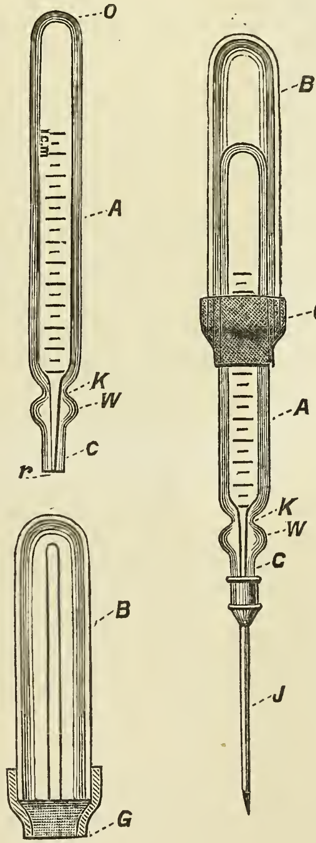
both on to the wheel R and through a tube P on to the test-tube. The surplus water collects in a reservoir, from which it passes out through an overflow pipe (not shown in the illustration).

By means of a thin metal rod, the handle M imparts a to-and-fro movement to a shallow rectangular metal tray, which is suspended by four wires to a wooden framework. The regular to-and-fro movement of the tray is effected by two small metal forks which act as guides. In fig. 80 is given a general view of the apparatus. In the tray are placed glass capsules to contain the pieces of organs or tissues which are to be stained, washed, hardened, or impregnated. In order to set the tray in motion, the plate S is levelled horizontally by the screw V, and water through a lead pipe is run into the compartment *b* of the hopper, so that it strikes against the wheel R and sets it in motion. The rapidity of the wheel's motion is regulated by different calibre of tube, &c.

As an example of how the apparatus works, it is stated that sublimate solutions, &c., can be extracted in two days, the spirit only requiring to be once removed.

To make gelatin tubes for the Esmarch method, the screw V is made to give a greater or less inclination to the apparatus, according as there is more or less gelatin in the tube (see fig. 79). The water stream is then run into the *a* compartment, so that it first runs out through the pipe P to cool the test-tube T, and then passes over the barrier into the *b* compartment, and so sets the wheel in motion.

Fig. 81.



Injection-syringe for Bacteriological Purposes.* — This syringe, which is the invention of E. Stroschein, consists of two glass tubes which are somewhat like ordinary test-tubes though smaller. The inner, narrower tube is prolonged at its front end to a conical point on which to fit the canula; at its posterior end is a small hole. The outer tube simply fits over the inner, and the two are connected with a caoutchouc band.

The syringe is filled by merely dipping the canula into the fluid to be injected, and then drawing the outer tube back as far as the elastic band permits, and so by creating a vacuum the fluid is sucked into the inner tube. Of course the fluid is injected by merely reversing the action. This little instrument, which is very moderate in price,

* Mittheil. aus Dr. Brehmer's Heilanstalt, 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 746–7 (3 figs.).

fulfils every requirement for bacteriological work as it is easily taken to pieces, and its constituent parts easily disinfected by dry or moist heat, or by chemical agents.

Staining the Flagella of Bacteria.*—Prof. F. Loeffler communicates a much improved method for staining the flagella of micro-organisms, the key to the procedure consisting in the greater or less acidity of the mordant. The quantitative differences in the reaction of the mordant are extremely slight, and vary with the different bacilli.

The best results were obtained from using 10 ccm. of tannin solution (20 + 80 water) to which had been added 5 ccm. of cold saturated ferrosulphate solution and 1 ccm. of aqueous or alcoholic solution of fuchsin, methyl-violet, or woolblack. This last pigment is used for dyeing wool without a mordant, and when dissolved in water is of a blue-black colour.

The foregoing solution, especially when made up with fuchsin, is to be regarded as the stock solution, and one which will stain the flagella of certain micro-organisms such as *Spirillum concentricum*, but for others the addition of an alkali or an acid is necessary. Thus, for typhoid bacilli 1 ccm. of 1 per cent. caustic soda solution is required, while *Bacillus subtilis* needs 28–30 drops, the bacillus of malignant œdema 36–37 drops, and so on. For cholera bacteria it is necessary to add 1/2–1 drop of sulphuric acid, for *Spirillum rubrum* 9 drops, to the 1 per cent. soda solution, the quantity of which is not however mentioned.

This is the mordant and it differs from that previously given by the author by certain omissions.†

The whole procedure now goes as follows. A small quantity of the pure cultivation is mixed up in distilled water, and with some of this the cover-glass is lightly smeared with a platinum loop. It is of the utmost importance that the cover-glass should be perfectly clean and free from grease or other impurities. The covers should be boiled in strong sulphuric acid, washed in distilled water, and having been immersed in ammoniated alcohol, dried on a clean cloth.

The bacteria, when spread on, are fixed in a flame. For staining flagella this is absolutely necessary, but it is also as important not to over-heat. The correct amount of heat may always be estimated by holding the cover between the thumb and forefinger, instead of using forceps; by this device overheating is avoided. While still warm, the mordant is applied. The cover-glass is then heated until it begins to vaporize (1/2–1 minute). It is then successively washed in distilled water and absolute alcohol.

The staining solution is then dropped on in quantity sufficient to cover the cover-glass, which is again warmed until the solution vaporizes and then the cover-glass is washed in distilled water.

The composition of the staining solution is ordinary neutral anilin water in which solid fuchsin is dissolved to saturation. To this as much of a 1 per cent., or still better 1 per thousand, soda solution is added as to bring it almost to the point of precipitation. Although it is not

* Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 625–39 (8 photographs).
† See this Journal, 1889, p. 711.

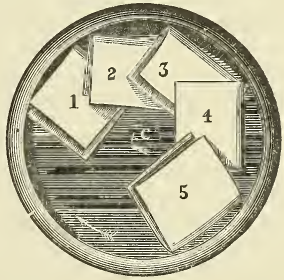
absolutely necessary to add the soda solution better results are thereby obtained.

With regard to the necessary addition of alkali or acid to the mordant, the author points out that there is some connection between this fact and the formation of acids and alkalies by certain bacteria: for the acid-forming bacteria required the addition of alkali, and the alkali-producers the addition of acid before they would stain.

Another interesting observation made by the author was that some bacteria possess tufts of flagella, and these are well demonstrated in the photographs accompanying this paper.

Staining Spinal Cord with Naphthylamin Brown and Examining with the Dark-field Illumination.*—For preparing serial sections of spinal cord, Herr O. Kaiser finds the following procedure useful. The sections imbedded in celloidin are removed from the knife with filter paper and placed at once in the following staining solution:—Alcohol, 100; water, 200; naphthylamin brown, 1. The sections folded up in filter paper are arranged in a glass capsule, as shown in the figure. Herein they may remain for some hours to two days. The sections when removed from the staining fluid are washed with 96 per cent. spirit and then placed on the slide. When the excess of alcohol is removed the sections are fixed to the slide by blowing ether vapour over them through a pipette bottle. As the sections become a little greasy, a few drops of absolute alcohol are run over them, after which the slide is placed in origanum oil, then in xylol, and the specimen finally mounted in balsam. Naphthylamin brown colours the chromophilous cells dark brown, while the chromophobous cells appear as bright objects on a dark ground. The blood-corpuscles are of a coppery red hue. In order to distinguish between the grey and white matter, it is necessary to use the dark-field illumination. This is easily done by inserting a stop in the Abbe condenser. The white substance now shows up as a bright yellowish-brown, while the grey matter is dark brown, all the finer details being quite clear. The blood-corpuscles are of a bright scarlet hue, so that the vessels seem injected.

Fig. 82.



Staining the Endings of Motor Nerves with Methylen-blue.†—Prof. A. S. Dogiel, after recommending this method, and alluding to the usual procedure, states that it may be simplified and improved in the following manner. The tissue removed from living or recently killed animals is placed on a slide or in a watch-glass containing some drops of aqueous or vitreous humour. To this are added two to three drops of a 1/15 to 1/16 per cent. solution of methylen-blue made up with physiological salt solution. In this condition the preparation is left exposed to the action

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 471–3 (1 fig.).
† Arch. f. Mikr. Anat., xxxv. (1890) pp. 305–20 (1 pl.).

of the air, but protected from the dust by a large watch-glass. The preparation may be examined from time to time under a low power to see how the staining is getting on. The effect varies extremely: thus the endings of motor nerves stain in 5–10 minutes, while the nerves in the retina require two or three hours or even longer.

As the staining disappears in a comparatively short time, it becomes necessary to fix the pigment. For this purpose picrate of ammonia is advised. This saturated aqueous solution precipitates the methylen-blue in a finely granular condition, rendering the rest of the tissue highly transparent. The length of time required for fixing the stain varies of course with the thickness of the tissue; some specimens are fixed in 20 minutes, while others require as long as 12 hours. The preparations are then mounted and examined in a mixture of equal parts of glycerin and distilled water.

Preparations which have been stained with methylen-blue may be hardened by immersion for 2–3 hours in a saturated spirituous solution of picrate of ammonia and then, having been imbedded in elder-pith or liver, sectioned with a razor. The sections are placed in glycerin. Or the stained tissue may be frozen and then sectioned.

By the foregoing method the author has obtained very excellent results, judging from the illustrations which accompany the text, from muscles of Amphibia and Reptilia. The procedure is less complicated than that where the stainings are obtained by injecting the vascular system with a solution of methylen-blue.

(5) Mounting, including Slides, Preservative Fluids, &c.

Arranging Diatoms.* — Mr. Cunningham states that he arranges selected diatoms by transferring directly from a strewn slide to the exhibiting slide by the aid of a "Kain's mechanical finger" attached to a Beck's 1/2-in. objective, the slide being manipulated by the left hand, and the bristle being directed into the field from the left-hand side. This method, he says, counteracts the effect of reversal of image, enabling every desired movement to be accomplished with ease and certainty. The right hand assists in racking the diatom from the slide high enough to clear the edge of the cover-glass upon which the diatoms are to be fixed. Very minute species are selected and isolated by this means.

New Mounting Dammar.†—A very superior mounting medium was accidentally discovered by adding by mistake liquor potassæ to a thick solution of benzol-dammar. After the lapse of some months, the jar, with a beautifully clear zone of some sort of gummy material superimposed upon a white one, was discovered. The clear zone, some 6 ounces, was drawn off and tested as to drying and other properties. It was found that it dried slowly, but ultimately set very firmly. Placed on a slide heated to a point that instantly vaporized water, it dried without forming a bubble. Used as a mounting medium on a hot slide, no bubbles were formed, and while in bulk the colour is somewhat darker than Canada balsam, in ordinarily thick mounts it is almost imperceptible.

* Journ. N.Y. Micr. Soc., vi. (1890) p. 60.
† St. Louis Med. and Surg. Journ., lviii. (1890) p. 37.

Alcoholic Method of Mounting Bryozoa.*—Miss V. A. Latham, when adopting the alcoholic method of mounting, first rings a cell of the brown cement and allows it to harden thoroughly; then, she says, "cover this entirely with balsam and benzol, and when dry again make it slightly sticky by a thin line of balsam which fastens down the cover-glass. Ring over all another layer of the last cement, and when dry use brown cement to completely seal the mount which, when dry, can be finished as the mounter wishes. Or, instead of the above method, after the organisms have been fixed and coloured, pass them through alcohol 30 per cent., 50 per cent, 70 per cent., and absolute, the last at least twice, and let them stand covered for 24 hours. Replace the spirit by pure benzol, remove about a tenth of the alcohol in which the organisms are placed with a pipette, and replace by the same amount of benzol; repeat this a number of times (about twelve) at intervals from 10 to 30 minutes. Great care must be taken that the benzol mixes thoroughly. After the last addition pour the fluid off and substitute pure benzol. At the end of 24 to 48 hours in the benzol, according to the size of the object, a fifth part of the Canada balsam dissolved in benzol is added; this is repeated at intervals of from a quarter to half an hour; the objects may now be preserved in the tubes till wanted, or mounted at once. In mounting. care must be taken that each drop holds in suspension a sufficient variety of the organisms. The method is not quite so tedious as it appears from the reading."

Kaiser's Glycerin-Gelatin.†—One part of the best French gelatin is macerated in six parts by weight of distilled water for about two hours. To these are added seven parts by weight of pure glycerin, and to every 100 grams of the mixture 1 gram of pure carbolic acid. The whole is then warmed for 10–15 minutes with constant stirring until all the lumps and flakes which form after the addition of the carbolic acid have disappeared. The decoction is then filtered through the finest glass-wool, which has been previously washed in distilled water, and placed still wet in the funnel.

* Microscope, ix. (1889) p. 141.
† Bot. Centralbl., i. p. 25. Cf. Jahrb. f. Wiss. Bot. (Pringsheim), xxxi. (1891) p. 400.

PROCEEDINGS OF THE SOCIETY.

The first Conversazione of the Session was held at King's College on Wednesday, the 27th November, 1889.

The following objects, &c., were exhibited:—

Mr. C. D. Ahrens:—Polarizing Binocular Microscope.

Mr. H. P. Aylward:—Patent Spring Clip for securing the covers of jars, &c.

Educational Series of Botanical Preparations.

Rev. G. Bailey:—Section of Coniferous Wood from Flint, Lewisham.

Mr. C. Baker:—Samoan Deposit under Zeiss' Apochromatic 1/2 in. N.A. ·65 and Abbe's Condenser with dark-ground illumination.

Test Objects under Apochromatic Objectives: Zeiss' 1/6 N.A. 0·95 and 1/8 oil-immersion N.A. 1·40 and Abbe's Achromatic Condenser.

Amphipleura pellucida × 1500 under new formula 1/12 oil-immersion N.A. 1·25 (Student's Series).

New Microscope Lamp, with horizontal and vertical rack movements suggested by Rev. Dr. Dallinger.

Automatic Microtome.

Bausch & Lomb Optical Co.:—Microscopes and Objectives.

Messrs. R. and J. Beck:—Podura Scale with new 1/18 oil-immersion.

Amphipleura pellucida with new 1/20 oil-immersion.

Mr. W. A. Bevington:—Section of Head of Indian Locust.

Mr. A. C. Cole:—Transverse Section of Human Left Median Nerve, stained for Photomicrography; and Photograph of the same slide.

Optical Vesicle of a Human Embryo in the sixth week. T. S.

Mr. Crisp:—Stereo-photomicrographs of Human Embryos.

Mr. Dadswell:—*Coryne pusilla.*

Membranipora pilosa.

Mr. F. Enock:—Slides of various Insects.

Mr. H. Epps:—Section of Bean, *Cacao Theobroma*, showing starch-grains *in situ.*

Mr. H. E. Freeman:—Parasite of Humble Bee, *Trichodactylus* sp.

Mr. C. Haughton Gill:—Diatoms prepared by a new method.

Mr. W. Godden:—Diatoms from Skye, N.B.

Mr. W. Goodwin:—Diatoms illuminated by new superstage illuminator.

Prof. J. W. Groves:—Transverse Section of Root of *Iris florentina.*

Transverse Section of Root of *Acorus calamus*, stained with acid methyl-green and borax-carmine.

Mr. J. D. Hardy:—*Vesicularia valkeria.*

Mr. John Hood:—*Bursaria truncatella*, adult form.

Mr. J. E. Ingpen:—*Licmophora flabellata* mounted in saturated solution of common salt by Mr. J. G. Tatem.

Cephalosiphon, &c.

Mr. R. Macer:—*Melicerta tubicolaria.*

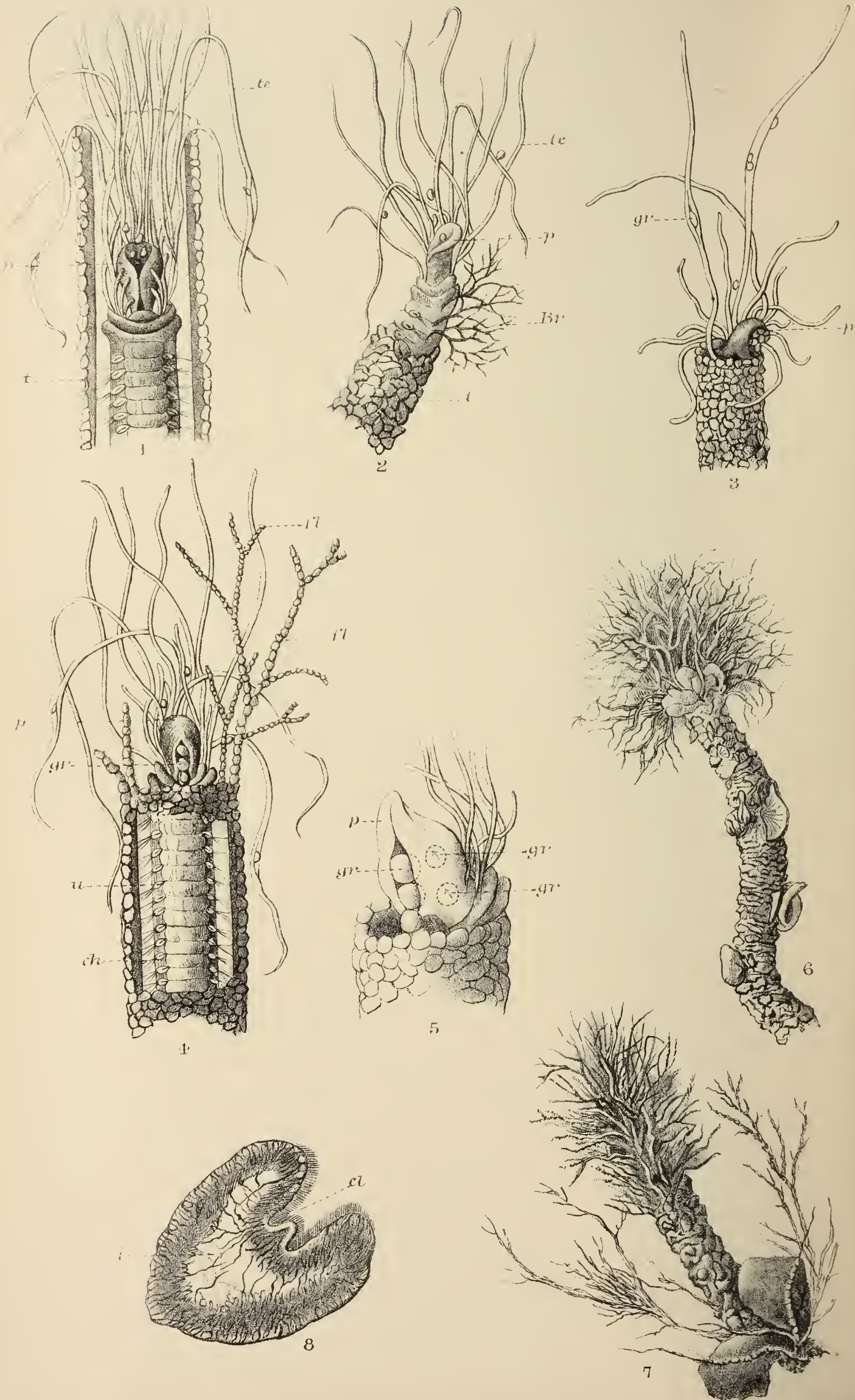
Mr. A. D. Michael:—*Cothurnicella cordieri* from Cherchel, Algeria.

Messrs. Powell & Lealand:—New cheap Oil-immersion 1/12 in. N.A. 1·28.
New cheap Oil-immersion 1/20 in. N.A. 1·26.
Mr. B. W. Priest:—Statoblast of *Uruguaya repens* Hinde, River Uruguay.
Mr. C. Rousselet:—*Anuræa aculeata*, *A. cochlearis*, *Asplanchna priodonta*, *Triarthra longiseta*, *Brachionus angularis.*
Mr. G. E. Smith:—Melaphyre with Agates *in situ*, Oberstein.
Silicified Coral, *Isastræa oblonga*, Portland, Tisbury.
Mr. W. T. Suffolk:—Flea mounted in glycerin in 1858.
Mr. J. J. Vezey:—Multipolar Nerve-cells (Corpuscles) from Spinal Marrow.
Mr. F. H. Ward:—*Nitella batrachosperma*, species new to Britain.
Section of Thorn of Rose.
Portable Stand for Steinheil Lens.
Messrs. Watson & Sons:—Type Slide of Diatoms from St. Peter.
Pollen of *Malope.*
Type Slide of Spines of Echini.
Transverse Section of *Ascaris*, showing Oviducts, Uterus, Alimentary Canal, &c.
Tentacle of Snail, showing Eye.
Section of Wall of Pitcher-plant, showing Glands.
Mr. T. Charters White:—Album of Photomicrographs.
Horizontal Section, Human Scalp.
Cartilage of Sheep.
Dental Exostosis.

The second Conversazione of the Session was held at 20, Hanover Square, on Wednesday, the 30th April, 1890.

The following objects, &c., were exhibited:—
Rev. G. Bailey:—Spicules and Foraminifera washed from base of *Euplectella.*
Mr. C. Baker:—Zeiss's Apochromatic Objectives.
Photomicrographs produced with Apochromatic Objectives.
Zeiss's Stand I*a* with new Mechanical Stage.
Mr. W. A. Bevington:—Polycystina.
Mr. P. Braham:—Crystallization of Metals by Electricity.
Crystals of Gold and Antimony in Carbon Disulphide.
Mr. E. T. Browne:—*Achorutes purpurescens.*
Smynthurus niger.
Mr. C. Haughton Gill:—Diatoms prepared by new process to show markings more clearly.
Mr. W. Godden:—Photomicrographs of Greek and Græco-Roman Gems and Coins.
Mr. J. D. Hardy:—Search-tank and Microscope.
Mr. R. T. Lewis:—New Zealand Coccidæ.
Mr. R. Macer:—*Fredericella sultana.*
Desmids.
Prof. Maskell:—*Inglisia Fagi*, *I. Leptospermi*, and *I. patella* from New Zealand.

Mr. A. D. Michael:—*Uropoda ovalis*, showing side view of spermatheca, perigynum, vagina, &c.
Mr. J. H. Mummery:—Section of Human Tooth, showing the Palps.
Mr. E. M. Nelson:—Photomicrographs of Diatoms, Pine, &c.
Mr. C. H. Oakden:—*Arrenuris caudatus.*
Messrs. Powell & Lealand:—*P. angulatum* and other Diatoms shown with 1/4 in. and 1/6 in. Apochromatic Objectives.
Photomicrographs produced with above objectives.
Mayall's Jewelled Fine-adjustment.
Mr. B. W. Priest:—Surface Organisms, 30 fathoms, Faröe Channel.
Messrs. Ross & Co.:—Wenham's Radial Microscope.
Schroeder's Camera Lucida.
Mr. T. B. Rosseter:—Entozoon from *Cypris cinerea.*
Strongylus from *Bufo vulgaris.*
Mr. C. Rousselet:—Rotifera with observation tank.
Mr. G. J. Smith:—Andesite, Mount Shasta, California.
Headon Hill Limestone, Christchurch Bay.
Lumachella (Fire Marble), Carinthia.
Basalt Dykes in Carboniferous Limestone, Carlingford.
Mr. T. F. Smith:—Photomicrographs of Diatom Structure.
Mr. W. T. Suffolk:—Glandular Hair of *Drosera rotundifolia.*
Mr. J. J. Vezey:—Sudoriparous Glands from the Skin of the Hand.
Mr. F. H. Ward:—*Bacillus tuberculosis* and broken-down Lung-tissue.
Messrs. Watson & Sons:—Type Slide of Eggs of Butterflies, Moths, &c.
Sporocarp of *Pilularia*, showing Spores.
Lieberkühn's Glands in Human Intestine.
Head of Lamprey, Section through Gills.
Section of Dodder on Heath.
Diatoms (about 200 specimens) from St. Peter, Hungary.



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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1890.

TRANSACTIONS OF THE SOCIETY.

X.—*The Tube-building Habits of Terebella littoralis.*

By Arnold T. Watson.

(*Read* 19*th November*, 1890.)

Plate XIV.

It is a well-known characteristic of certain Annelids, of the family Terebellidæ, that they inhabit tubes which they have themselves carefully constructed with grains of sand, stones, broken shells, and similar materials cemented together, and their method of building such tubes has, in a general way, been more or less clearly described by Dalyell, Gosse, J. G. Wood, and others. Some of these dwellings are simply tubes of an internal diameter adapted to the worm which inhabits them, and of variable length, the greater portion being buried in the sand, but with a free open end rising above the surface. In certain species (as *Terebella littoralis*) this free end is ornamented with remarkable arborescent or pectinate processes, the delicate

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EXPLANATION OF PLATE XIV.

Fig. 1.—Sketch of living Terebella in tube *t*, collecting sand with its tentacles *te*, and showing especially the lips *p* used in building. Ventral view. Tube in section.

„ 2.—Ditto, showing tentacles *te*, lip *p* stretched upward to receive building material, and the tree-like branchiæ *Br* protruding from mouth of tube *t*. Lateral view.

„ 3.—Terebella placing sand on edge of tube by means of lip *p*; grains of sand *gr* shown travelling down tentacles *te*.

„ 4.—Sketch showing hood-shaped prostomium (lip) *p* placing sand-grains *gr* one above another in line to form filaments *fl*. Some filaments already formed. Uncini *u*; setæ *ch*. Ventral view.

„ 5.—Diagram showing lateral view of prostomium *p*. Sand-grains *gr* travelling up inside to be attached in due course.

„ 6.—Sketch of tube with pebbles and broken shells attached, showing flattened bushy head of sandy filaments. Natural size. From a rock-pool.

„ 7.—Sketch of bushy tube with large pebbles and coralline attached, showing close resemblance between the sandy filaments and the coralline. Natural size. From a rock-pool.

„ 8.—Transverse section of tentacle of Terebella, showing the hollow interior *i*, and the ciliated groove *cl*. × 100.

beauty and gracefulness of which render it an interesting question how the animal manages to construct them; and the method actually adopted, which I observed last year, has, I believe, not been previously described. In order to render a clear account of the process, it is necessary to preface a few words descriptive of the animal.

These worms, which are to be found on almost all the sandy sea-shores of Europe, vary in size from an inch to possibly eight or nine inches in length, according to age. The body is divisible into two main portions—the anterior, which in a large specimen is a quarter of an inch or more in width, consisting of about twenty segments; and the posterior, which is prolonged into a cylindrical tail, of small diameter, composed of numerous segments. The anterior extremity is the prostomium, from the back of which spring a large number of long, simple, filamentous tentacles almost surrounding the mouth. The buccal segment, which follows, is produced in front and forms an under lip. Then come three segments, each bearing a pair of beautiful arborescent red branchiæ, followed by the notopodial fascicles, containing their peculiar setæ. Ventral to these are situate the oval tori, bearing the uncini, which latter are continued throughout the body, the form of the tori varying in the posterior portion of the animal. The tentacles, the prostomium, and probably the lower lip, are the organs employed in the building operations. The tentacles, which in section present a cordate shape (fig. 8), are long, hollow, tubular, very extensile filaments, communicating with the body-cavity, the perivisceral fluid from which travels freely up them, favouring their extension and contraction. These filaments are richly provided with vibratile cilia on the two edges, and also on the central line of the side which is turned towards the mouth of the worm. Their sides are covered with mucus-secreting cells, and the two outer edges of the tentacles are capable of being folded together longitudinally, so as to form either a hollow cylinder or a semicylindrical channel at will.

This power, assisted by the secreted mucus, enables them to grasp at any point small stones or grains of sand, which are then passed forward to the prostomium, either by ciliary, or a kind of peristaltic action (the sides of the tentacle closing up behind the stones), or by sudden muscular contraction of the tentacle, or by a combination of all three. The chief office of the tentacles, in the building work, is to collect and carry materials, though they also sometimes temporarily support large stones, shells, &c., which are being fastened to the edge of the tube. They also collect food for the worm, and are believed to discharge certain other functions, the discussion of which is outside the object of this paper. The large upper lip is a most wonderful organ, capable of assuming an infinite variety of forms, and is, if I may use the expression, the bricklayer.

In what may be called common walling, i. e. building the tube itself, the operation is simple, and easy to observe. Sand-grains,

small stones, &c., are collected by the tentacles, and in the accompanying drawings are shown travelling towards the prostomium. Some of the tentacles are quite short, and it is evidently their duty, when material is brought within their range by the others, to transfer it to the prostomium, which organ stretches up in a most eager manner to receive it, bending expectantly towards the tentacles, and turning now this way and now that until satisfied, reminding one of the action of an elephant's trunk. This attitude is shown in the lateral view, fig. 2. When the material reaches the prostomium it is quickly rolled over within the mouth and covered with a white transparent cement; the animal then bends over and deposits it upon the free edge of the tube, as shown in fig. 3, immediately after which it holds up its lips for a further supply.

This operation may be watched for long periods together, but the observation of how the sandy fringe is built is a most difficult matter, and was only attained after about fourteen days of almost constant watching. In building the body of the tube the sand is deposited, sometimes grain by grain, at other times several grains at once, and during the work the body of the worm is usually well within the tube, the fore part protruded only just far enough to work comfortably, the lips constantly receiving new material and placing it, *as received*, upon the growing edge of the tube; but in building the sandy branching filaments a different method is pursued. A moderately large grain of sand is first laid as a foundation stone; then the creature usually retires into its tube, and the tentacles collect and carry down to it a large supply of grains of sand, which is all received by the lips, and no doubt duly coated with the secreted cement. The animal now slowly emerges, and lays first one grain upon the foundation stone; then, whilst still holding this with the lower portion of its lip, it forces a second grain, out of the supply in its mouth, above the first, through the upper portion of its lip. It then slides the whole lip upward to the second grain, which it holds as before, passing forward above it a third grain, and so on until the whole supply is exhausted, the worm keeping hold with its lip all the time, and withdrawing at lightning speed as soon as the last grain is attached, the whole operation occupying, in the cases I observed, from 5 to 10 seconds only. The straightness of the filament is secured by the above means combined with a very steady and gradual advance of the body of the worm as each grain is added. When the top grain is laid the creature has often emerged so far that the whole three pairs of branchiæ are outside the tube. This advance is of course produced by the setæ pushing against the sides of the tube, whilst steadiness is secured by the hold which the uncini have upon its membrane-like lining.

Figs. 4 and 5 will make the above description intelligible. Fig. 4 is a front view, showing the prostomium, as temporarily a hood-shaped organ, clasping with the lower portion of its lip the second of a series of grains which it is fixing, whilst a third grain is

being forced into position through the upper portion. Fig. 5 is a diagram showing a side view of the same organ, with other grains travelling up inside to be attached in due course.

Any long, thin, cylindrical particles, such as spines of *Echini*, spicules of sponges, &c., are utilized for fringe-making, and are deposited separately. The filaments built under my observation consisted of single grains of sand cemented one above the other in a straight or curved line, but those found on some tubes are delicate columns consisting, in cross section, of two or three grains placed side by side and cemented together. It is probable that in these cases a column is first built of single grains and afterwards strengthened or thickened by additional material.

The fringe-building operations appear to be chiefly carried on during the night, and many hours and even days may, and frequently do, elapse between each favourable opportunity for observation.

M. A. de Quatrefages,* writing in 1865, and Messrs. J. T. Cunningham and G. A. Ramage † in 1887, describe the filaments of the fringe as hollow "tubules," and say that "when the head of the worm is protruded the tentacles are partly contained in them, and so protected." This is certainly not the case in any specimen which I have seen, and I have examined a very large number. The filaments are solid columns, along which the tentacles do frequently stretch themselves, but which it is impossible for them to penetrate, for on examining the tube internally no opening to these "tubules" is visible. Moreover, it seems to me that were the hitherto prevailing idea correct, these "tubules" would, so far from protecting the animal, prove rather a source of danger by impeding its hasty retreat. The object of these filaments it is impossible to divine with certainty, but three or four advantages occur to me as possibly connected with them. (1) They may act as snares to catch food; I have several times seen the worm pass its upper lip and tentacles along the filaments. (2) They may form favourable vantage points from which the animal can fish around with its wonderful tentacles, supplying, as it were, rods to the fishing lines. (3) These filaments or fringes are set upon two semicircular flaps, facing each other, and falling together when the water leaves them; so they may be a protection by thus closing the tube. Or (4) it may be a case of protective mimicry, the resemblance to the surrounding growth of coralline being very close.

I have found that the tubes can be preserved as museum specimens by treatment with sea-water saturated with calcium chloride, and subsequent drying, during which the fringe should be carefully lifted and picked out with a needle. I have one such specimen with a spray of coralline attached (just as taken from the pool), in which it is almost impossible to distinguish the one from the other (fig. 7).

* Quatrefages, A. de, 'Hist. Nat. d. Annelés Marins et d'Eau douce,' ii. (1865) p. 346.

† Trans. Roy. Soc. Edinb., xxxiii. (1888) p. 664.

From a sanitary point of view these fringes might be regarded as likely to hinder the free expulsion of refuse matter, but this is not the case. Such matter is thrown with some force quite clear of the tube by the animal doubling itself into a U-shape, and forcing the long narrow posterior portion of its body well out of the mouth of the tube.

I may remark that the semicircular flaps appear to be formed *after* the fringe by a process of shelly plating filling up the spaces between the filaments. Usually the fringed summit only of the tube projects above the sand, but the portion buried is sometimes of very great length. This summer I obtained tubes no less than 19 in. long, and I am not sure that even then the whole length was secured, as it is exceedingly difficult to dig them unbroken out of the loose wet sand into which they descend almost vertically.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA :—Embryology, Histology, and General.

a. Embryology.†

Intensive Segregation.‡—Rev. J. T. Gulick advances from the position maintained in a previous paper on "Divergent Evolution through Cumulative Segregation." There he enumerated no less than eighteen sets of natural causes dividing species into sections which do not interbreed, and sought to show how these causes, often acting in complex combination, tend to produce cumulative segregation and divergent evolution. His object now is to show how separation from the first involves more or less segregation, or how segregation, that at first divides the species into sections with reference to some one endowment, is always tending toward intensified segregation in which the sections present differences in regard to an increasing number of endowments.

Experience in domestication shows that segregation is a controlling factor, whether it be in the deliberate preservation of special varieties, or simply in that prevention of crossing which necessarily results when separate sections of a domesticated species are under the care of distinct tribes of men. But in nature species are similarly divided into sections, which are usually assorted with reference to some definite point or points of character, and divergent evolution results. Division of the species involves some segregation, and whenever the transforming influences of the other factors of evolution begin to operate in the different sections, the initial segregation is inevitably intensified and the divergence increased. For it is in the last degree improbable that change produced

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Journ. Linn. Soc. Lond.—Zool., xxiii. (1890) pp. 312–80.

by these factors of transformation in sections prevented from crossing should be completely parallel in the different sections, even when exposed to the same environments. The next step which is taken in the latter half of the present paper, is to show "that the relations to each other of varieties, species, genera, and the higher groups are such as would necessarily be presented if all such differences were the result of evolution that is always dependent on some form of segregation, but not always on diversity of natural selection, nor always on exposure to different environments."

Mr. Gulick maintains and cites facts in support of his view that "persistent differences, whether varietal, specific, or generic, are not all adaptational, for some of them have no relation to utility; and that adaptational differences are not all advantageous, for some of them relate to adaptations that would meet with equal success if the organisms should exchange habitats; but that in every case divergence, whether utilitarian or non-utilitarian, whether advantageous or disadvantageous, is not maintained without independent generation," or, in other words, requires the prevention of interbreeding.

The paper contains an interesting discussion of the various (eight) factors of transformation and of the different forms of selection, while the argument is illustrated by an account of divergent evolution in the land-molluscs of Oahu and in a number of insects. But we are not able to do more than give the general argument by which Mr. Gulick shows how segregation is intensified.

Definition of Species.*—Prof. F. Lataste offers the following definition of a biological species. The category of organized beings designated under the name species is composed in space and time:—

(1) Either of two collections of individuals of different sexes, one of which—the female—is generally capable of being fecundated by a male, or of a single collection of non-sexual or hermaphrodite individuals; the individuals of each collection, on the one side, present with one another the same relations of resemblance as with all the normal descendants of any one of them (general case), or at least with some of the descendants (cases of polymorphism and alternation of generation); and, on the other side, the morphological interval between the most distinct individuals of each collection is filled up by intermediate individuals in such a way that we pass from one to the other by an insensibly gradual series of modifications.

(2) And of all the individuals which certainly arise from those comprised either in the single or in the two collections, as above defined, whatever be the degree in which they may differ, either normally and collectively (polymorphism, alternation of generation), or accidentally and individually (monstrosities).

Comparison of Oogenesis and Spermatogenesis.†—Prof. O. Hertwig makes a fresh comparison of oogenesis and spermatogenesis in Nematodes, and finds in this "a basis for the discussion of disputed questions." The mother-sperm-cell corresponds to the immature ovum. During a prolonged resting-state the nuclear substance in both is peculiarly pre-

* Zool. Anzeig., xiii. (1890) pp. 480–3.
† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 1–138 (4 pls.).

pared for two cell-divisions, the second immediately succeeding the first. Before division the amount of nuclear material is the same in the two sets of cells. During the two divisions there is no multiplication of nuclear substance; the results of division have only half as much nuclear material as there is in ordinary nuclei after dividing once. The number of chromatin elements in the nucleus of the mother-sperm-cell and in the germinal vesicle is the same as that of an ordinary nucleus at the middle of division, or double that of a nucleus in the preparatory stage of division. But the morphological value of these (germinal) elements is different, in consequence of an origin divergent from the normal process. For while eight daughter-chromosomata normally arise from the simple longitudinal cleavage of four filaments, here they arise by the double longitudinal cleavage of only two. Yet these two contain the same amount of material as the four formed by transverse division at the beginning of karyokinesis. Since the immature ovum and the mother-sperm-cell go through the same processes of nuclear division, with all their divergent characteristics, in precisely similar fashion, the products of division must also have the same morphological rank. The two daughter-sperm-cells correspond to the ovum and the first polar body; the four spermatozoa are comparable to the ripe ovum, the second polar body, and the two spheres arising from the division of the first; the polar bodies have therefore the morphological rank of rudimentary egg-cells.

Prof. Hertwig then asks whether the processes observed in the spermatogenesis of *Ascaris* occur elsewhere, and whether the formation of polar bodies is genuinely a double division of cell and nucleus. In the second part of the memoir he criticizes the theories of Minot, van Beneden, Weismann, Boveri and others, and enters into a long discussion of the facts and theories in regard to polar bodies. His own opinion is that they are abortive ova, that their production is comparable to that of spermatozoa from a mother-sperm-cell, and that their persistence is explained by the physiological importance of the reduction which they effect in the mass of the germinal vesicle.

Development of the Primitive Kidney in Man.*—Dr. H. Meyer has been able to study the development of the mesonephros in a human embryo of the first month. He describes the mesonephric ridge, which did not exhibit either on its external or internal margin any thickening or double layer of epithelial cells. The proximal part of the Wolffian duct arises from the mesoderm and is at first united to the pleuro-peritoneal epithelium, while its distal portion is united to the ectoderm. It is here, as elsewhere, a tubular communication between the body-cavity and the surface, and its ends are separated by the longitudinal growth of the embryo. The mesonephric canals and the Malpighian bodies are then described. Each segment of the mesonephric blasteme has three connections :—With the elements of the median plate or future peritoneal epithelium, with the cells of the corresponding primitive segment, and with the wall of the aorta. The first two connections show that the blasteme consists of elements both of the median and of the segmental or protovertebral plates.

* Arch. f. Mikr. Anat., xxxvi. (1890) pp. 138–72 (2 pls.).

Theory of the Placenta.*—Prof. C. S. Minot sums up his theory of the placenta of rodents as follows:—The egg fixes itself by the thickened ectoderm of the area placentalis, the ectoderm coalescing with the uterine epithelium; the maternal epithelium, including the glands, disappears by degeneration and absorption, though deeply-situated remnants of the glands may remain; the maternal capillaries of the submucosa become much enlarged, and their epithelium degenerates; the connective-tissue cells of the same layer are modified into decidual cells, and in the rabbit, in part into glycogenic cells; fœtal villi grow in place of the glands; they branch and increase, and penetrate the maternal tissue until there is little more than room left for the maternal blood-courses in the intervillous spaces.

Inversion of the Germinal Layers in Rodents.†—Dr. T. Biehringer discusses the problems connected with this curious process discovered by Bischoff in the development of the guinea-pig, investigated by Kupffer and Selenka in the field-mouse (*Arvicola arvalis*), by Fraser in the rat, by Biehringer in *Arvicola* (*Hypudæus*) *amphibius*, known also in the mouse, and probably occurring in *Dasyprocta*. The author shows that the conditions are simplest in *Arvicola*, next in the domestic mouse, then in the rat, most divergent in the guinea-pig, and describes each of these in turn. He explains how the inversion occurs, indicates clearly how the divergence supports, and does not weaken, the morphological constancy of the germinal layers, and shows what questions still remain unanswered, but the complicated facts of the case we must leave untold.

Development of Superior Incisors and Canines of Sheep.‡—Miss F. Mayo states that at a certain stage in the development of the sheep, the dental lamina exists throughout the canine and incisor regions of the upper jaw. Its anterior portion, which is the last to develope and the first to abort, does not attain so prominent a condition as its lateral portion. After advancing in development for a time, it retrogrades, and finally disappears. In the canine region the dental lamina gives rise to an enamel germ, which never reaches a stage of functional activity; its central cells are not transformed into a stellate reticulum, and the Malpighian layer never produces enamel, while in later stages both disappear. In this region there is no trace of a dentine germ. In the region of the incisors the evidences, even of the beginnings of tooth-development, have almost disappeared. There is every reason for supposing that the disappearance of the teeth has been a progressive process, beginning with the middle incisors and gradually affecting the teeth set further back.

Blastopore of Anurous Amphibia.§—Herr R. von Erlanger gives an account of his own observations on the fate of the blastopore, and comes to the conclusion that when his results are compared with those of Schanz and Morgan, we are justified in believing that the anus arises from the most ventral part of the blastopore, while the most dorsal forms the neuropore and neurenteric canal. In the Anura, that part of the blastopore from which the anus arises becomes temporarily closed, and

* Biol. Centralbl., x. (1890) pp. 114–22.
† T. c., pp. 403–14.
‡ Bull. Mus. Comp. Zool., xiii. (1890) pp. 247–58 (2 pls.).
§ Zool. Jahrb., iv. (1890) pp. 238–56 (2 pls.).

the anus only arises by a later breaking through; in the Urodela, on the other hand, the most ventral part of the blastopore never closes. The formation of the anus of the Anura is therefore subject to secondary modification. The recent work of Prof. Götte supports this view.

Development of Kidneys in Fat-Bodies in the Frog.*—The following is a summary of the results of the studies of Prof. A. Milnes Marshall and Mr. E. J. Bles, on the development of the kidneys in fat-bodies of *Rana temporaria*. The head-kidney and its duct are mesoblastic structures, in the formation of which the epiblast takes no part; but the cloacal openings of the ducts are formed partly by outgrowth from the gut. In early larval life the head-kidney is a large and complex organ, but it begins to degenerate in tadpoles about 20 mm. in length. The first stage in its degeneration is the great and irregular dilatation of the tubules, accompanied by the destruction of their epithelial lining; this is apparently due to the blocking of the archinephric duct. Ultimately the head-kidney disappears completely, its three nephrostomes closing up and undergoing atrophy. The peritoneal opening of the oviduct is a new formation, and not a persistent nephrostome. The tubules of the Wolffian body begin to form shortly before the head-kidney degenerates, they develope from behind forwards, and are at first segmentally arranged; they are formed from the mesoblast between the aorta and the archinephric ducts, and arise independently of the peritoneum. Nephrostomes are formed at an early period, and open into the body-cavity. The fat-bodies are formed from the anterior ends of the genital ridges.

Development of Blood-vessels of Frog.†—Prof. A. Milnes Marshall and Mr. E. J. Bles have studied the development of the blood-vessels in *Rana temporaria*. As to the heart, they found that it is developed before any of the vessels of the visceral arches, and before the dorsal aortæ. The muscular wall of the heart is formed from the splanchnic layer of mesoblast; the inner or endothelial wall is derived directly from the hypoblast of the ventral wall of the pharynx and of the hepatic diverticulum. The heart is from the first in connection at its posterior end with the veins of the yolk-sac and of the liver; its several chambers become marked off by constrictions before its anterior end acquires any connection with blood-vessels. The apparent thickening of the wall of the ventricle is due to the development of an internal muscular reticulum, and the absence of nutrient vessels in this wall is explained by this arrangement. The valves of the truncus arteriosus are established before the metamorphosis. The blood-vessels arise as irregular lacunar spaces in the mesoblast, and these spaces open into each other and so form continuous channels. The mesoblast-cells surrounding the channels become converted into the epithelial walls of the vessels. The further growth of the vessels is sometimes effected by the formation of solid cellular cords, continuing the lines of the vessels. The axial cells of the cord break down and so give rise to tubular vessels. Blood-corpuscles are at first absent; when they do appear they are formed from the walls

* Studies from the Biol. Lab. Owens Coll., ii. (1890) pp. 133 58 (1 pl.).
† T. c., pp. 185-268 (3 pls.).

of the vessels themselves; they are true cells, at first spherical in shape and laden with yolk-granules.

The dorsal aortæ are, with the exception of the vitelline veins and the heart, the first vessels to appear. They arise on each side as a number of isolated lacunar spaces along the roof of the pharynx, which open into one another and so form continuous vessels. In each branchial arch there appears a lacunar efferent vessel at the level of the external gill; this extends dorsally, meets and opens into a diverticulum of the dorsal aorta. Immediately behind the efferent vessels, at the level of the gill, an afferent vessel appears; this is also lacunar and at first independent. After describing in detail the development and fate of the vessels the authors point out that throughout the early stages of development there is a striking resemblance in arrangement, relations, and proportions between the arterial and venous systems of the tadpole and those of an adult Elasmobranch. The external and internal gills apparently form one continuous series of structures. The tadpole undergoes a distinct increase in bulk before the opening of the mouth, and it is suggested that in the early stages, nutriment is absorbed through the sucker.

Process of Maturation in Ova of Selachians.*—Prof. N. Kastschenko points out that the process of maturation of meroblastic eggs has not yet been clearly made out. In one thing only have all investigators agreed, and that is that the germinal vesicle passes to the animal pole of the egg, and then finally disappears. The formation of polar globules was not, as a rule, observed, and was consequently denied, while no explanation was given as to whence came the ovarian nucleus.

Comparatively recently, the admirable work of O. Schultze on the process of maturation in the Amphibian egg has thrown much light on the subject. Although the author's observations are not complete they are, he thinks, sufficient to justify us in concluding that the process of ripening of the Selachian egg is, in all its primary phenomena, exactly comparable to that of holoblastic eggs. During maturation the polar globules are formed by karyomitotic division of the egg-cell; of the two one is separated off in the ovary and the other probably at the time of fertilization. The germinal vesicle, as a whole, is certainly not expelled from the egg, though some of its constituents may be. Prof. Kastschenko has not observed the granular coagulum noticed by several observers, and he thinks it much more probable that the fluid contents of the germinal vesicle, as well as its membrane, are simply dissolved in the yolk of the egg. The chromatin filaments of the polar spindle of the globules and of the ovarian nucleus are the same chromatin filaments (or their descendants) as are to be seen in the resting germinal vesicle long before the maturation of the egg.

Development of Teleostean Fishes.†—Dr. R. Fusari describes the first stages in the development of *Cristiceps argentatus*, and bases on his observations a number of conclusions. During the first stages of segmentation the perivitelline membrane continues to yield elements to the blastodisc, but later on, when the merocytes no longer remain as

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 428–42 (1 pl.).
† Atti R. Accad. Lincei—Rend., vi. (1890) pp. 70–8.

individualized units, it is very doubtful whether elements can migrate from the parablast to the blastodisc or embryo. The majority of the nuclei of the perivitelline membrane, after a period of indirect division, degenerate into chromatolysis. The function of the membrane is to elaborate the lecithin material in adaptation to the nutrition of the embryo.

As to the germinal layers, the primitive entoblast divides into four portions:—(*a*) into a chordal portion which gives origin to the notochord, and (*b*) to the secondary entoblast, (*c*) into the elements of the mesoblast, and (*d*) into the residual or lateral entoblast. The interruption between the chordal and lateral entoblast marks the communication between the archenteron and the peritoneal cavity, where the mesoblastic folds have arisen by an abbreviation of that true evagination seen in *Amphioxus*. But the greater part of the mesoderm arises directly from gastrulation, as a peristomial formation especially on the dorsal lip of the blastopore.

Development of the Lamprey.*—Herr C. Kupffer publishes the first part of an extended memoir on the development of *Petromyzon planeri*. He accepts Böhm's account of the fertilization of the eggs, and emphasizes the fact that the fertilized ovum and its segments exhibit two distinct portions, namely, active "protoplasm" free from yolk lying around the nucleus, and outside this passive "paraplasm" rich in yolk. Kupffer's observations on the first steps in segmentation agree with those of Max Schultze. The time between fertilization and the hatching of the *Ammocœtes* varies markedly with the temperature, being seventeen days at Königsberg but only eight at Naples. It may be divided into five periods:—(1) from the beginning of development till the definite separation of the central nervous system from the ectoderm; (2) till the formation of optic vesicle and the auditory pit, and the segmentation of the mesoderm begin; (3) till the nasal plate begins to be formed and the two anterior gill-pockets are recognizable; (4) till the invagination of the mouth begins, when the gill-pockets are three in number, the auditory vesicle is constricted off from the epidermis, and cross-striped muscle-fibrils appear; (5) from the invagination of the mouth till hatching.

The cells of the most superficial layer of the morula unite into a blastodermic epithelium, beginning in an area on the future dorsal surface and spreading ventralwards. But before this is completed the blastopore is seen, so that gastrulation begins before the blastosphere is finished. A group of cells on the dorsal lip of blastopore, where ectoderm and endoderm are in contact, persists and increases, and determines the growth of the embryo in a caudal direction beyond the anus. This group is called the "teloblast."

Kupffer then describes the "keel," in which the rudiments of central nervous system and notochord are combined, and shows how this becomes divided anteriorly into the paired head-ganglia, the brain, and the notochord. The formation of the central nervous system is peculiar, but it is not so divergent as it seems, for the dorsal portion of the keel which becomes the nervous system is not the product of a "delamination"

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 469–558 (6 pls.).

(as Shipley expressed it), but arises from a folding of the single-layered ectoderm of such a nature that the sides of the fold remain in contact. The teloblast seems like a reserve for both ectoderm and endoderm, as it comes into intimate relations with organs which arise from both layers; but in *P. planeri* it certainly does not give origin to the mesoderm. It is comparable to the "sickle" which Kupffer has described in other Vertebrate embryos.

In the second period, the nerve-cord is separated from the ectoderm, the gut becomes differentiated, and the mesoderm appears. There is a striking want of symmetry in the neural strand at the region of transition from head to trunk. But of most interest during this period is the endoderm in its two portions, the epithelial wall of the gut, and the yolk-cells which function as reserve-material. For now the formation of the dorsal mesoderm and of the segmental plates sets in. In the head-region, where the gut is not surrounded by the yolk-cells, the endoderm forms hollow dorsal folds in true enterocœlic fashion. But in the trunk-region the massive cushions of yolk-cells, lying on each side of the axial organs, change gradually into mesoderm, acquire a cœlom cavity, and are separated from the ventral mass. Yet this apparent combination of enterocœlic and schizocœlic processes is not strange; it depends upon the absence or presence of these endodermic yolk-cells. The open mesodermic fold of the gut in the head-region passes gradually with the thickening of its walls and the obliteration of its cavity into the massive mesodermic cushion of the trunk.

At this stage in his memoir Kupffer ceases to sketch the history of each period in its entirety, and proceeds to trace the rise of the various systems. The remainder of the present paper is devoted to the nervous system and sense-organs. As concerns the peripheral system, Kupffer recognizes at the end of the fourth period five distinct rudiments, which subsequently come into connection:—dorso-spinal and ventral-spinal nerves, lateral ganglia, branchial nerves, and epibranchial ganglia.

β. Histology.*

Intra- and Inter-cellular Ducts.†—Prof. F. Leydig supports the opinion which he expressed many years ago that the roots of a duct proceeding from a cell are continued into spaces lined by spongioplasm, and wonders, not unnaturally, that a recent observer of the intracellular nature of the ducts in the nephridia of the leech has not appreciated the figure in the well-known 'Histologie' of 1857. Some recent observations on the exploding glands of *Brachinus* (along with which *Agonum* must be ranked as another "bombardier-beetle") have convinced the veteran histologist that efferent canals may arise from intercellular ducts, and he recommends the study to those interested.

Cell-Studies.‡—In the present communication Dr. T. Boveri deals with the relation of the chromatic nuclear substance in the formation of the polar globules and in fertilization. From the study of various animals he is led to certain conclusions, which may be thus summarized.

* This section is limited to papers relating to Cells and Fibres.
† Biol. Centralbl., x. (1890) pp. 392–6.
‡ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 314–401 (3 pls.).

I. *Formation of Polar Globules.*—The emission of polar globules seems to be always associated with true karyokinetic division, that is, the chromosomes that are present are always divided in the formation of every polar globule, and the halves shared between the two daughter-cells. When the chromosomes are rod-like or filamentar, cleavage takes place in a longitudinal direction. In one and the same ovum the two polar spindles have the same number of chromosomes. The so-called maturation of the ovum presents us with a case in which the fate of the several chromosomes may be followed out during the whole course of the existence of a cell—the mother egg-cell. The fact that the chromosomes which are present in the division of this cell are identical with those which the cell had at its formation, induces us to conclude that the same is the case with those cells where the fate of the several elements has escaped observation. A peculiarity which may often be observed in the chromatic elements of the first polar spindle is that there are four of them. On this point the author dilates at some length. The elements emitted in the two polar bodies are, to our eyes, exactly identical with those which remain in the egg. In such eggs as have the polar spindles composed of two "ray-suns" the poles of the second spindle arise by division of the pole of the first, which remains in the egg.

II. *Fertilization.*—There is a certain variability in the relation of the chromatic substance in fertilization. The most striking point at first sight is the fact that in some cases the egg- and sperm-nuclei fuse, while in others they divide independently and break up in the fusing. The former has, up till now, been erroneously regarded as the more common process. As these differences have been observed in the several nuclei of eggs of one and the same animal, we must suppose that they have no significance. The author points out that if it does not matter whether the nuclear material of a cell is united into one nucleus or divided into two or several vacuoles, it will follow that the ordinary simple "nucleus" is neither morphologically nor physiologically an entity, but is, so to speak, only a common house for a number of equivalent, mutually independent constituents, which are just as well able to exercise their functions separately as together. These independent parts are the chromosomes. The other characters of the nuclei may exhibit considerable variations. There are cases in which the paternal chromosomes (e. g. in *Tiara*) arise directly from the homogeneous chromatin-body of the spermatozoon, and others in which a resting nucleus is first developed from the elements of the sperm-head. It is therefore certain that the paternal chromatin, as it is introduced into the egg, is not always at the same stage of development, and this explains certain differences that have been observed in the relative maturity of fertilized ova and of the fertilizing element. The paternal chromosomes which are given off from the sperm-nucleus to form the first cleavage-spindle agree in number, size, form, and apparent structure with the maternal elements supplied by the egg-nucleus.

III. *Numerical Relations of Chromosomes.*—For every species the number of chromosomes is constant, that is, there are the same number in the karyokinetic figures of homologous cells. There are, however, the most marked differences between the homologous cells of different,

even though very closely allied organisms, as may be seen from the following table :—

	In Polar Spindles.	In Cleavage Spindles.
Ascaris megalocephala (type Van Beneden) ..	1	2
" " (type Carnoy)	2	4
Coronilla sp.	4	8
Spiroptera strumosa and *Ophiostoma mucronatum* ..	6	12
Filaroides mustelarum	8	16
Echinus microtuberculatus and *Sagitta bipunctata*	9	18
Tiara sp.	14	28
Pterotrachea, *Carinaria*, and *Phyllirrhoë*	16	32

The number of chromosomes in the first is the same as that in the second polar spindle. The number formed from the egg-nucleus is similar to that of the elements devoted to the egg on the formation of the second polar body. As the egg- and sperm-nucleus give the same number of chromosomes to the first cleavage-spindle it follows that this last has twice as many chromosomes as each polar spindle, and also an even number. The generative cells of an organism contain half as many chromosomes as the first embryonic cell from which the organism arose. There are, it is to be noted, certain irregularities in some of these numerical relations, so that a definite number of chromosomes is not always characteristic of a species.

IV. *Chromatic Substance in Parthenogenesis and the Significance of Polar Bodies.*—The author thinks that the best hypothesis to explain the phenomena of parthenogenesis is that which regards the polar globules as rudimentary ova, and this he calls the phylogenetic or egg-hypothesis. When the second polar spindle is not removed it is clear that the number of chromosomes in such an egg is the same as in a fertilized ovum. He subjects the theories of Weismann and others to a close critical examination, and finds that facts which destroy the value of their hypotheses add strength to his.

Accessory Corpuscle of Cells.*—Dr. Emma Leclercq has made an investigation on the accessory corpuscle of the spermatic cell in which great attention was paid to the mode of fixation. She comes to the conclusion that these cells are more complicated than has hitherto been supposed. As a rule, they may be considered to be cells with two nuclei —the chromatic nucleus or nucleus of authors, which she calls passive, though not in a physiological sense, and the "Nebenkern" or accessory corpuscle which is the active nucleus and corresponds to the archiplasm of Boveri. The latter is a constant element of cells, and plays an important part in the spermatozoon, where it very probably forms the fibrillar axis of Braun, Jensen, and Ballowitz. There is a chromatic axis which is surrounded by achromatic fibrils, while the true nucleus, which is here and there traversed by the axis, forms for it a second envelope in that region which is called the head. This last is preceded by a procephalic achromatic portion which is derived from the accessory corpuscle.

* Bull. Acad. Roy. Belg., lx. (1890) pp., 137-48.

Red Blood-corpuscles.*—Prof. W. H. Howell has made an extended study of the formed elements of the blood of Mammals. He finds that in the very young embryo there are two forms of red corpuscles, one large, oval, and always nucleated, which resembles the corpuscles of the lower vertebrates; and one small, biconcave, circular in outline, and nucleated or not. The latter are the true mammalian corpuscles, and the former possibly represent ancestral corpuscles, The true mammalian corpuscles lose their nuclei by extrusion. In the first half of embryonic life new red corpuscles are produced in the liver from groups of mesoblastic cells outlining the position of future blood-vessels. The central cells of these cords become red corpuscles, while the peripheral form the walls of the veins. It is probable that new red corpuscles are formed in all parts of the body when blood-vessels are being developed. In the second half of embryonic life red corpuscles are formed in the liver, the spleen, and the marrow of the bones. In the Cat the two former lose this function three or four weeks after birth.

Leucocytes and blood-plates do not occur in the circulating blood of young embryos, but make their appearance in later embryonic life. The red corpuscles produced in the red marrow first occur as nucleated cells; these differ in structure with age. Two extreme types may be recognized —one mature and ready to be converted into a non-nucleated corpuscle, and one immature, as shown by the character of the nucleus and the amount of hæmoglobin. This latter multiplies by karyokinesis and the daughter-cells form mature nucleated red corpuscles, which lose their nuclei by extrusion. The liberated nuclei go into solution in the blood-plasma. The immature red cells are derived from spherical colourless cells, erythroblasts, which have a definite histological structure and are found in the marrow; they multiply actively by karyokinesis. These erythroblasts are derived from larger embryonic cells, which are usually described in the adult as ordinary marrow-cells, which also multiply by karyokinesis. The leucocytes of the blood are derived from lymphocytes; these enter the circulation as small corpuscles with vesicular nuclei and scanty protoplasm, and they are not amœboid. They develope into larger cells, with finely granular protoplasm, which possess the power of amœboid movement. These have at first an oval vesicular nucleus which afterwards becomes elongated; from this last form the multinucleated cells are derived by fragmentation of the nucleus.

Giant-Cells of Marrow.†—Prof. W. H. Howell divides the giant-cells of the marrow into two classes. Some are polykaryocytes or multinucleated giant-cells found in developing bone, in pathological formations, or porous bodies kept in lymph-cavities. Others are megakaryocytes or large nucleated giant-cells found in the red marrow of the adult and in the blood-forming organs of the embryo. The former have no special formation, are not related to the latter, and are formed by the fusion of smaller cells in consequence of too rapid growth. The megakaryocytes form a peculiar class of cells; they arise from the growth of small lymphoid cells, and afterwards reproduce by direct division. During their life they form a secreted material which can be seen for a time by the Microscope, but which finally dissolves in the

* Journal of Morphology, iv. (1890) pp. 57–116 (1 pl.). † T. c., pp. 117–29.

plasma. They seem to take no direct part in the production of nucleated red corpuscles or erythroblasts; after a certain period the nucleus alters in such a way that it stains diffusely and then fragments. This seems to be a degenerative change, and probably ends in the total disintegration and total dissolution of the cell.

γ. General.

Production of Light by Animals and Plants.*—M. R. Dubois has been led by a long series of investigations to the conclusion that the production of light in both animals and plants is connected with the conversion of colloidal protoplasmic granules into crystalloidal granules under the influence of respiration.

Origin of Vertebrates from a Crustacean-like Ancestor.†—Dr. W. H. Gaskell proposes to discuss, in a series of chapters, the origin of Vertebrates from a Crustacean-like, or more properly proto-Crustacean, ancestor. He commences by marshalling the evidence given by the central nervous system and pineal eyes of the *Ammocœtes* of *Petromyzon planeri*. The central nervous system of all Vertebrates consists of two parts—one nervous and one non-nervous; the latter is in part free from admixture with nervous elements, and partly helps to form the supporting tissue for them. This non-nervous part forms a canal round which the nervous material is grouped in the same manner as the nervous system is grouped around the alimentary canal. This similarity of grouping is not merely anatomical, but is also physiological; the functions of the supra-œsophageal ganglia, of the infra-œsophageal, and of the ventral chain, correspond to the functions of those parts of the Vertebrate central nervous system which are situated in the same anatomical position, with respect to the non-nervous tube, as the corresponding ganglia of the Crustacean with respect to the alimentary canal. From these facts Dr. Gaskell has already drawn the conclusion that the non-nervous tube of the Vertebrate central nervous system is the altered alimentary canal of the Crustacean ancestor of Vertebrates.

What, therefore, we may expect to find in a very low Vertebrate are more conspicuous vestiges of the mouth, œsophagus, and cephalic stomach than in higher forms; the pineal eye should be easily recognizable, and of a Crustacean type, while the proportion of nervous to non-nervous material should approach nearer to that found in Crustaceans than in higher Vertebrates. Similarly there should be in *Ammocœtes* something comparable to the large glandular organ known as the liver in Crustaceans.

In searching for the cephalic stomach, or for the mouth and œsophagus, Dr. Gaskell thinks his requirements are fulfilled, and further evidence in support is afforded by the relation of the infra-œsophageal and thoracic ganglia to the walls of the cephalic stomach, and the relation of the ventral ganglia to the walls of the intestine. The peculiar tissue, which is different from any other, the cells of which appear degenerated, which contains lines of pigment between its cells, which is found only in lower Vertebrates, and is gradually pushed out of existence in the higher classes as the brain increases in size, fills up

* Comptes Rendus, cxi. (1890) pp. 363–6.
† Quart. Journ. Micr. Sci., xxxi. (1890) pp. 379–444 (4 pls.).

the space around the brain because it represents some pre-existing organ which was of importance to the animal from which the Vertebrate sprung; such an organ is clearly the "liver" of Crustacea. The significance of the pigment is next discussed.

From his study of the optic organs, the author concludes that the original Crustacean-like ancestor had a pair of median eyes, each with its optic ganglia and connections with both supra- and infra-œsophageal ganglia; the right eye remained functional longer than the left.

With regard to the structure of the supra- and infra-œsophageal ganglia, Dr. Gaskell points to the fact that both the Crayfish and the Ammocœtes have giant-cells, large cells, and small cells. It is because the central nervous system of the Vertebrate is the direct descendant of the Arthropod that there is such similarity between them, and not because, as Bellonci supposes, similarity of function requires similarity of structure. The author just quoted has directed particular attention to the close similarity of the olfactory organ of the two groups. In the Ammocœtes the olfactory glomeruli resemble exactly in appearance the reticulated substance ("Punctsubstanz") of the Arthropod nervous system. But the author postpones the discussion on this point to the next chapter, in which the cranial nerves will be examined.

Origin of Vertebrates from Arachnids.*—Dr. W. Patten was first led to suspect that the Arachnida were the ancestors of Vertebrates from the fact that concentration and specialization of head-segments is, among Invertebrates, greatest in the Arachnida. The points which he now attempts to prove are (1) that in the Scorpion the cephalothoracic neuromeres, sense-organs, and mesoblastic somites present, in a general way, not only the same specialization and the same numerical arrangement in groups, but also the same difference as a whole from the body-segments, as do the corresponding parts in the Vertebrate head; (2) that the Arachnid cartilaginous sternum represents the primordial cranium of Vertebrates; (3) that in the Trilobites and Merostomata the internal structure of the cephalothorax resembles in some respects that of *Scorpio* and *Limulus*; (4) that the remarkable fish-like *Pterichthys* and related forms, judging from their external structure, are closely related to the Merostomata, and serve to connect Arthropods with Vertebrates; and (5) that the embryology of Vertebrates in its main features can be reduced to the Arthropod type.

The author brings forward suggestions rather than facts in support of his theory, but his views as to the classification of animals may be of some interest. (See Table, p. 703.)

New Theory of Pterichthys.†—Mr. A. Smith Woodward subjects Dr. Patten's speculations as to fossil fishes to a severe criticism. He says that when it is suggested that the so-called dorsal shield of *Pterichthys* is on the hæmal aspect of the animal, an ichthyologist, at any rate, is unable to regard the statement as anything beyond unjustifiable speculation. The figures copied by Dr. Patten have been shown by Traquair to be inaccurate; the "cervical suture" of *Pterichthys* is nothing more than a superficial slime-canal, and the same remark

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 317–78 (2 pls.).
† Ann. and Mag. Nat. Hist., vi. (1890) pp. 314–6.

Dr. Patten's Classification of Animals.

Vertebrata.

Urochorda. Cephalochorda.

SIPHONEURA.

Central nervous system tubular.

Eyes on neural surface. Retinas to both median and lateral eyes inverted.

Ichthyoida { *Cephalaspis*, *Pterichthys*, *Pteraspis*, *Bothriolepis*.

Arachnida. Merostomata. { *Limulus*. *Eurypterus*.

Trilobites.

PELTACEPHALA.

Head shield-shaped. Eyes on hæmal surface.

SYNCEPHALA.

Divided into Head, Body, and Tail.

Head-segments 9–13; in four groups; first three head-segments devoid of appendages. Terminal segments more or less fused to form a urostyle. Eyes median and lateral. Median eyes 2–4, in a common sac or tube; retinas inverted.

Insecta. Crustacea.

Myriopoda.

PSEUDOCEPHALA.

Brain segmented, originally post-oral.

Annelida.

ENCEPHALA.

Brain unsegmented, pre-oral.

SEGMENTATA.

CŒLENTERATA. ECHINODERMATA ?

PROTOZOA.

may be applied to other of the "sutures," when they really exist. In fine, the resemblances which are regarded as homologies are really superficial.

Abnormal Repetition of Parts in Animals.*—Mr. W. Bateson brings forward, for the present without any comment, several instances of the abnormal repetition of parts in animals. Those enumerated here are the cases of a crab (*Cancer pagurus*), in which the endopodite of the third maxilliped was represented by a chela; of repetition of the pincers of chelæ in Crabs; of a beetle (*Chrysomela banksi*) with three complete tarsi on one leg; and of an *Antedon* with abnormal repetition of the brachial structures.

B. INVERTEBRATA.

Zoology of Victoria.†—In Prof. M'Coy's twentieth decade only two plates are devoted to Bryozoa; there are figures of a fine Bombycid (*Chelepteryx Collesi*), of *Ibacus Peronii*, and of three starfishes which have not before been figured of the natural colour; one, *Asterina calcar*, is the commonest of Victorian starfishes.

Zoology of Fernando Noronha.‡—Mr. H. N. Ridley, assisted by a number of specialists, has published a report of the zoological collections made by him during his visit to Fernando Noronha; previous to this expedition, no land or fluviatile species of Molluscs, of which eight are now known, had been obtained from the island; three new Crustacea were collected.

Cellulose-reaction in Arthropoda and Mollusca.§—Dr. H. Ambronn reports that Schultze's solution (chlor-zinc-iodide) gives a violet colour, which is very near to, if not identical with, the colour-reaction of vegetable cellulose, when applied to a body which seems to be nearly always associated with the true chitin of Arthropods. The genera examined consist of *Eupagurus*, *Homarus*, *Scyllarus*, and others; in all these the inner layers of the carapace as well as the tendons give the reaction and exhibit a very strong pleochroism. The reaction may sometimes be hastened by previous boiling in caustic potash. Various Copepods, Ostracods, Spiders, Orthoptera, and Hymenoptera gave similar results. Among other classes of animals they were only seen in Mollusca, and there not commonly.

Mollusca.

γ. Gastropoda.

Revision of British Mollusca.‖—The Rev. Canon A. M. Norman continues his revision of the British Mollusca, and now deals with the Pulmonata; 107 species are enumerated, but the varieties are not given.

Cypræa testudinaria.¶—Dr. B. Haller devotes the second of his studies on the morphology of the Prosobranchiata to *Cypræa testudinaria*. Although Bouvier was acquainted with the nervous system of the Cypræidæ he placed them with the Tænioglossata, far from the Rhipido-

* Proc. Zool. Soc. Lond., 1890, pp. 579–88.
† Proc. Zool. Vict., Decade xx. (1890) pls. 191–200.
‡ Journ. Linn. Soc., xx. (1890) pp. 473–570 (1 pl.).
§ Mittheil. Zool. Stat. Neapel, ix. (1890) pp. 475–8.
‖ Ann. and Mag. Nat. Hist., vi. (1890) pp. 327–41.
¶ Morphol. Jahrb., xvi. (1890) pp. 259–99 (2 pls.).

glossata. Dr. Haller proceeds to discuss the affinities of *Cypræa*. As to the form of its shell it is clear that it is due not to spiral formation, for that is really very slight, but to the great development of the right-hand side of the anterior portion of the shell. This may be correlated with the great elongation of the anterior part of the shell which lies above the gill-cavity. The increase in length leads to the elongation of the left auricle and the liver. The Cypræidæ are allied to the Tænioglossata by the characters of the radula, the separation of the pleural ganglia from the pedal cords and their fusion with the cerebral ganglia, the abbreviation of the enteric canal, the histological differentiation of the two lobes of the kidney, the development of a seminal groove and of a penis in the male, and, finally, the separation of the rectum from the ventricle.

The author thinks the result of his investigations is to show that the Cypræidæ are very old forms of the Tænioglossata, which should be associated with the Rhipidoglossata; they form, in other words, an intermediate link between these two great divisions of the Prosobranchiata. With the Paludinidæ and *Cyclophorus* they form a group which may be called the Architænioglossata. As there is a rudimentary right auricle in the Cypræidæ and perhaps also in their allies, the division of Monotocardia and Diotocardia is shown to be out of consonance with the facts.

Swammerdam's Vesicle in Aplysia.*—Sig. G. F. Mazzarelli finds that the so-called vesicle of Swammerdam, which has been credited with many functions, from that of an ovary to that of a copulatory pouch, is connected, along with a seminal vesicle, to a duct which is the left portion of the divided hermaphrodite duct and opens near the vulva; that it contains spermatozoa in varying abundance, and also ova in many cases, besides free spherules of lecithin, globules of fat, albumen-granules, and much liquid; its function is that of purifying the spermatic fluid from all extraneous matter. This is an important process in these Molluscs and it is probable that some doubtful structures in other Gastropods have a similar function.

δ. Lamellibranchiata.

The Margin of the Mantle.†—Dr. B. Rawitz describes the margin of the mantle in Arcaceæ, Mytilaceæ, and Unionaceæ. In *Arca* it is divided into three folds: from the cleft between the internal and median folds the epicuticula is produced; the median fold bears the eyes; the cells of the outer fold pour forth a secretion utilized in forming the shell. The glands which are variously distributed on the margin are of two kinds, some forming mucin, others secreting a poisonous and protective product. Rawitz describes the compound or conical eyes and the invaginate cups, and differs somewhat from both Carrière and Patten in regard to the details of their structure. As to the function of the former he grants that they are visual, and explains their abundance as the natural result of the loss of the head and of concentration on the only available position—the mantle-margin, where moreover their wide distribution is of use to a passive bivalve like *Arca*, which cannot

* Zool. Anzeig., xiii. (1890) pp. 391–9.

† Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 539–641 (4 pls.).

turn itself about. The invaginate cups are not supplied by any nerves, and cannot be optic.

In the Mytilaceæ there are also two kinds of glands, muciferous and poisonous. The peculiar knob-like prominences on the mantle-margin of *Pinna* are certainly not eyes but glands, though they are very remarkable in being directly innervated. The characteristics of *Mytilus*, *Modiola*, and *Lithodomus* are described in detail. In Unionaceæ the mucin-forming glands alone are present. According to Flemming, the abundant mucous material of bivalves is secreted by the mucous cells in the meshes of the connective tissue, but Rawitz denies this to be the case in the Ostreaceæ, or in *Arca noæ*, *barbata*, *tetragona*, *lactea*, *Nucula nucleus*, *Mytilus edulis*, *Lithodomus dactylus*, or *Pinna nobilis*, while he allows it for *Arca diluvii*, *Pectunculus glycimeris*, *Modiola barbata*, and the Unionaceæ. It is interesting, however, to notice that the product in Unionaceæ is different from that in the other three forms. Finally, Rawitz points out that the occurrence of amorphous secretions in the connective tissue seems a symptom of degeneration as seen for instance in *Arca diluvii*, and that the younger species in a phylogenetic series show preponderant secretory activity and degenerate sensory structures.

Molluscoida.

α. Tunicata.

Development of Pyrosoma.*—Prof. W. Salensky finds that the embryo of *Pyrosoma* arises from both fertilized and unfertilized elements, since the formation of the cyathozoid is due, not only to the blastomeres, but also to the "kalymocytes," as the author terms the "internal follicular cells" of Kowalewsky. The first differentiation of the germinal layers is seen in the separation of the cells into two strata, an ectoderm and a meso-entoderm, of which the latter is further differentiated into a many-layered mesoderm and a single-layered entoderm. The mesoderm appears in the form of two typical cœlome pouches, but of these only the left developes. It is modified into axial mesoderm and a pericardial sac, while the right pouch breaks up into cells which are afterwards scattered in the body of the cyathozoid.

β. Bryozoa.

Gemmation of Bryozoa.†—Herr O. Seeliger commences his memoir with an account of the development of the entoproctous Bryozoa, as illustrated by *Loxosoma*. The history is very similar to that of *Pedicellina*. Parts of the ectoderm and mesoderm give rise to buds, the endoderm of which is formed from the outer layer by a process comparable to that of gastrulation by emboly. From the basal portion of the invagination the digestive tract is formed, and from that which remains always in connection with the endoderm arises the atrium and the outer covering of the tentacles. On the other hand, there are certain differences; the point at which the buds are formed is different, for in *Loxosoma* it is the body-wall of the upper part, and in *Pedicellina* the stalk. Again, the topographical relations of the body-regions of the buds to those of the

* Biol. Centralbl., x. (1890) pp. 225-33.
† Zeitschr. f. Wiss. Zool., l. (1890) pp. 560-99 (2 pls.).

mother are different, for in *Pedicellina* the dorsal side of the bud is turned towards the ventral, and not, as in *Loxosoma*, to the dorsal side of the mouth. The most striking difference lies in the fact that the buds of *Loxosoma* become set free from the mother and form new points of attachment, while in *Pedicellina* they remain permanently connected with the parent, and a new colony can only be formed from a larva. The possession of a pedal gland by the buds of *Loxosoma* is another point by which this form can be distinguished from *Pedicellina*.

In his study of the gymnolæmatous forms, Herr Seeliger has investigated especially *Bugula avicularia*, while *B. flabellata*, *Membranipora pilosa*, and *Eucratæa Lafontii* (?) have also been used. The process of budding is described as being very simple. The ectoderm and mesoderm give rise to the bud; from the outer layer is formed the body-wall of the bud, and, as in the embryonic development from the blastula, the polypide is formed by a gastrula-like invagination. The latter gives rise to the tentacular sheath, the outer walls of the tentacles, and the digestive tract with all its parts. The basal portion of the invagination is constricted off from the proximal, and at only two points does connection obtain; these become the mouth and anus. While the basal part is divided into the several sections of the enteron, the tentacles rise up from the anterior part. These are at first arranged bilaterally, and are set in the form of a horse-shoe; it is only later on that they form a closed circle.

The mesoderm of the mother is partly arranged around the polypide invagination in the form of a unilaminate epithelium, while other mesenchymatous cells remain scattered in the primitive body-cavity. The mesodermal epithelium gives rise to the tissue which fills the tentacular cavities, and the fine flattened epithelium which forms a peritoneal covering to the enteric canal as far as the base of the tentacles. The author has not followed out the fate of the free mesoderm-cells; it is possible that they give rise to the various muscular bands which traverse the body-cavity, and to the gonads.

Dr. Seeliger points out the close agreement that exists between the mode of development of the ento- and ectoproctous Bryozoa; the sole important difference lies in the relations of the mesoderm, but this is due to the differences in its structure. In the Entoprocta the separate mesenchyme-cells pass into the primary body-cavity of the bud, where they divide, and, during life, have the form of a connective tissue without ever becoming arranged in epithelial lamellæ. In the Gymnolæmata, among the Ectoprocta, the enteric canal has, in its developed stage, a mesodermal epithelial investment, while a similar, at least complete, layer is always absent from the body-wall. For the rest, the body-cavity is, as in the Entoprocta, traversed by connective tissue and other mesodermal organs. The large muscular bands which arise from the mesenchyme have exactly the histological characters ascribed by the Hertwigs to the mesoblast-musculature. In the Phylactolæmata there is not only an epithelial mesoderm-layer around the enteron, but one lies against the ectoderm, so that the body-cavity is truly an enterocœl.

With regard to the character of the mesoderm in the adult, the three groups of Bryozoa form a continuous series. In the Entoprocta a connective-tissue-like mesenchyme lies in the primary body-cavity; in

the Gymnolæmata there is, in addition, an endothelial investment surrounding the enteron; and in the Phylactolæmata a mesodermal epithelium is applied to the ectoderm.

After some remarks on the phylogeny of the Bryozoa, which is a peculiarly difficult problem, Dr. Seeliger points out that the processes of gemmation in the Bryozoa show how tissues which are, histologically, very definitely differentiated, may again take on quite an embryonic character. In them, as in the budding Tunicata, no support is to be found for the doctrines of Heredity propounded by Weismann. The author says that he has sought for but has not been able to find any evidence of a removal of histogenetic plasma from the ectodermal cells that form the polypide-invagination, which might render explicable the return to embryonic relations.

Larva of Flustrella hispida.*—Dr. H. Prouho finds that the larva of this Bryozoon has the same plan of organization as that of the cheilostomatous forms and as the larva of *Alcyonidium mytili*. The most striking points in its structure are the presence of two chitinous valves covering the aboral region, the differentiation of the mesoderm into numerous muscles and cellular layers, the most important of which is situated immediately below the aboral ectoderm, the presence of a nervous system, and the reduction of the hood to a sensory button or aboral organ which is connected with the pyriform organ by a musculo-nervous tract. Several of these characters ally the creature to *Cyphonautes compressus*. The larva possesses two kinds of organs; those which, during metamorphosis, pass directly to the primary zoœcium and appear to be of no use to the free larva, and those which perform functions useful to the free larva, and are destroyed when larval life ceases; they are utilized by the primary individual as reserve nutriment. The internal sac and the parietal muscles belong to the former category, while to the latter three belong the pyriform and aboral organs and the corona.

The fixation of the larva is effected, as in all larvæ that are provided with an internal sac, by the evagination of that organ. The corona, the pyriform organ, and all the integuments, are retracted to the interior; the aboral organ is invaginated below the ectoderm, and the larval organism becomes a closed sac, the free or frontal wall of which is formed by the aboral ectoderm of the free larva, while the basal part is formed by the internal sac.

As soon as the free larva has become fixed, the phenomenon of histolysis commences; this disorganizes much of the larval tissues and converts them into a number of nucleated spheres or histolytes, which become intermingled with the yolk-spheres and are, like them, put to use by the young polypide. The larval tissues which undergo histolysis are the nervous system, all the muscles except the parietal, the pyriform organ, the corona, the aboral organ, and all the oral integuments. The larva then passes into the cystid-stage.

The ectoderm of the cystid secretes a thick cuticle which forms the entocyst of the primary chamber; the aboral mesodermic layer becomes fused with the corresponding membrane which invests the internal sac

* Arch. Zool. Expér. et Gén., viii. (1890) pp. 409–59 (3 pls.).

in the free larva, and a continuous mesodermic membrane is formed which envelopes all the elements which were primitively free in the cavity of the larva, as well as all the products of histolysis. The cystid is also provided at its aboral pole with a thickened disc consisting of two layers; of these, the outer and ectodermic arises from a thickening of the aboral ectoderm, while the internal layer, which is mesodermic, arises from a corresponding thickening of the mesoderm. This meso-ectodermic disc is destined to form the polypide.

Preceding investigators have thought it probable that the aboral organ of *Flustrella* takes part in forming the polypide, but it really does nothing of the kind. The polypide arises altogether from the meso-ectodermic disc, which is formed independently of the aboral organ. The vesicular rudiment results from a simultaneous invagination of the two layers of the disc, and this subcuticular invagination is produced after the degeneration of the aboral organ.

The internal (ectodermic) layer of the rudiment forms the lophophore, the outer wall of the tentacles, the nerve-ganglion, the internal lining of the invaginated sheath, the pharynx, the rectum, and the mesenteron. The outer (mesodermic layer) forms the inner wall of the canals of the tentacles, the outer covering of the invaginated sheath, the retractor muscles of the polypide, the occlusor muscles of the chamber, and the investment of the digestive-tube.

South Australian Polyzoa.*—Mr. P. H. MacGillivray publishes an additional list of Polyzoa, founded on a collection of 119 species, 71 of which were not in his previous list. Three appear to have been hitherto undescribed.

Arthropoda.

Histological Arrangement of Pigment in Eyes of Arthropods.†—Mademoiselle M. Stephanowska has investigated the histological arrangement of pigment in the eyes of various Arthropods under the influence of direct light and complete darkness. She finds that light and darkness do influence the arrangement of the pigment, and that this is shown by the movement of the pigment-cells and the pigment-granulations. The general characters in complete darkness are—the pigment is not distributed uniformly, but there are large, very compact masses, chiefly at the base of the cones; the pigment-cells are more contracted, and are consequently more distinct; they also cover a smaller number of the optic elements, and these latter are more distinct than they are after exposure to light. In good light the pigment is much more uniformly scattered, and there are but rarely localized masses; the pigment-cells are elongated towards the corneæ and towards the retinulæ. In consequence of this, the refractive and sensory elements of the eye are less distinctly visible than in darkness, and the contours of the pigment-cells are themselves also less distinct. The pigment seems paler, for it is extended over a larger surface.

In some Insects the pigment, under the influence of strong light, is changed into droplets of fatty appearance, the size and arrangement of which vary much in one and the same eye. This phenomenon was

* Trans. Roy. Soc. South Australia, xiii. (1890) pp. 1–7 (1 pl.).
† Rec. Zool. Suisse, v. (1890) pp. 151–200 (2 pls.).

observed in *Eristalis*, *Libellula*, and *Stenobothrus*. The varying influences of light and darkness are not manifested equally in the eyes of all Insects, for in some the changes are scarcely noticeable, while in others they are strongly marked.

When we consider the universal presence of pigment in the eyes of all animals, even the simplest, we cannot fail to see that it plays an important part in the physiology of vision. As it is now known that the eyes of both Vertebrates and Arthropods possess the power of adapting the arrangement of the pigment to the quantity of light, we shall not be astonished if it is discovered that the eyes of other animals possess a similar power.

α. Insecta.

Power of Sight of Insects.*—From observations made on the visits of insects to flowers, Herren W. O. Focke and E. Lemmermann conclude that Lepidoptera and Diptera are in many cases attracted to flowers chiefly by the sense of smell; while with Hymenoptera this is much more rarely the case, but occurs in the lime. Insects see clearly in only the immediate neighbourhood of the object; with Apidæ the impression becomes indistinct at a distance of ten cm., and many Lepidoptera and Diptera are even more shortsighted. More distant objects convey to insects only a very indistinct visual impression; but differences of colour can be perceived from a comparatively great distance. A brightly coloured flower one cm. in diameter in green foliage can be seen by Apidæ and Lepidoptera at a distance of 1–2 metres. The perception of colour in insects is developed in very different degrees, and in different directions in different species.

Formation of the Dorsal Region in the Embryos of Insects.†—Dr. J. Nusbaum adds to the five different ways in which Graber showed that the dorsal region might arise, a sixth observed in the embryo of *Meloe*. The entopygma ruptures on the ninth day of development, the ectopygma not before the nineteenth day. The ruptured portions of the entopygma, connected with the ectoderm, lie midway between the dorsal and the ventral surfaces of the embryo, and unite with the wall of the still unruptured ectopygma. Thereafter the ectopygma is ruptured below the point of union, the whole of the lower or ventral portion gradually degenerates, but the dorsal portion with the united part of the entopygma contracts to form the dorsal wall of the embryo. The final boundary of the back, however, is wholly due to the entopygma, for the implicated portion of the ectopygma is invaginated into the yolk as a "dorsal tube," the cells of which are soon scattered in the yolk, and take no direct share in building up the embryo. Unlike Graber, Nusbaum maintains that differences in the relative quantity of nutritive yolk, in its consistence, and in the duration of development, influence the mode in which the dorsal region is formed. He regards the differences in the development of this region as in many respects cenogenetic, and would seek to associate them with the special adaptations of the embryo and larva to various conditions of life.

* Abhandl. Naturw. Ver. Bremen, xi. (1890) pp. 439–43. See Bot. Centralbl., xliii. (1890) p. 36.

† Biol. Centralbl., x. (1890) pp. 110–4.

Closed Tracheal System in Insect Larvæ.*—The late Dr. H. Dewitz was engaged on some observations on the closed tracheal system of larvæ, the chief results of which may be thus summarized. In the young stages of the Odonata and Ephemeridæ there is an open tracheal system, and in some of the families thoracic stigmata are seen at a very early stage. Mature nymphs of Æschnidæ, Libellulidæ, and Agrionidæ were found to be able to inspire as well as expire air by the stigmata. If all the gill-lamellæ of young Ephemerid larvæ are cut off, the animals undergo ecdyses in which gill-lamellæ are newly formed.

Insects Accepted or Rejected by Birds.†—Mr. A. G. Butler has, this year, continued his experiments with insects and birds. He is convinced that the tastes of the latter not only differ in individuals of the same species, but that the same individuals in consecutive years vary as to their likes and dislikes; the largest British spider is not an object of fear to any insectivorous bird; the imago of *Abraxas grossularia* is far from being distasteful, although the larva is distinctly so to many, if not all, insect-eaters. Neither caterpillars nor birds have the same notions of beauty as human beings. Mr. Butler's observations do not afford much support to some recent speculations as to protective coloration.

Evolution of Bristles, Setæ, and Tubercles of Caterpillars.‡—Prof. A. S. Packard has a paper, full of observations, in which he brings together hints as to the evolution of the bristles, spines, and tubercles of certain caterpillars, which appear to result from a change from low-feeding to arboreal habits; these are illustrated by the life-histories of some Notodontians.

He comes to the conclusion that the more prominent tubercles, with the spines or bristles arising from them, are hypertrophied piliferous warts; the warts with the seta or hair which they bear being common to all caterpillars. The hypertrophy or enlargement was probably due in the first place to a change of station from herbs to trees, involving better air, a more equable temperature, and perhaps a different and better food. The enlarged and specialized tubercles developed more rapidly on certain segments than others, because the nutrient fluids would tend to more freely supply parts most exposed to external stimuli. These last were largely due to the visits of Insects and Birds, and the result was a mimicry of the spines and projections on the trees; the colours were due to light and shade, and the general result was protective mimicry or adaptation to tree-life.

The cause of the hypodermic cells at the base of the spines of some forms becoming specialized to secrete a poisonous fluid is not yet known. After primitive forms, members of different families, had become established on trees, a process of arboreal segregation or isolation would set in, and intercrossing with low-feeders would cease. Heredity would cause a succession of generations perfectly adapted to arboreal life, while natural selection would constantly tend to preserve new varieties, species, and genera, and would not cease to act in a given direction, so long as the environment remained the same. Prof. Packard is of opinion that the first steps in the origination of a species, genus, family,

* Zool. Anzeig., xiii. (1890) pp. 500-4 and 525-31.
† Ann. and Mag. Nat. Hist., vi. (1890) pp. 324-7.
‡ Proc. Boston Soc. Nat. Hist., xxiv. (1890) pp. 494-560 (2 pls.).

order, or even class, which cause the appearance of variations, are, in the beginning, due to the primary (direct or indirect) factors of evolution (Neolamarckism), while the final stages are due to the secondary factors, segregation and natural selection (Darwinism).

Biology of Lepidoptera.*—Dr. A. Seitz publishes the first instalment of an account of the general life of Lepidoptera. He speaks first of the manner in which Lepidoptera are distributed; of cosmopolitan forms, like *Pyrameis cardui*, which flies swiftly and far, has a long life and much hardiness, and is moreover able to rest with spread wings upon the water; how others stand or fall with the presence or absence of the food-plants on which their monophagous caterpillars live; what advantages there are in acquiring the habit of polyphagy; how manifold are the means of transportation, e. g. in railway carriages and ships; how some forms are constitutionally prone to wander; and how the family of Psychidæ, in spite of their wingless females, has come to be very widely distributed.

In the second chapter he relates his own observations and those of others on the active wanderings of Lepidoptera over land and sea, singly or in swarms, as adults or as caterpillars, and after discussing the various reasons for this, falls back on the belief in a genuine "Wandertrieb." Then follows a criticism of generalizations in regard to geographical distribution, and a constructive attempt to improve these. He discusses the factors determining the distribution of Lepidoptera in continents, countries, and localities; submits a number of phænological and geographical tables; and notes the characteristics of the Ethiopian, Indo-Australian, and Neotropical fauna. An account is given of a restricted area of woodland in South Brazil, where the great majority of the insects were blue (not the Lepidoptera alone, but Coleoptera, Hemiptera, and Diptera), although but a few miles off a red colour was dominant, and he argues that the facts could not be explained as due either to mimicry or to general protective resemblance. In the fourth chapter the influence of climate and weather on Lepidoptera is discussed, with abundant details as to the effect of mild winters and hot summers, rain and wind; and even the periodicity of the sun-spots is not forgotten.

New Excretory Organs in the Silkworm.†—Prof. E. Verson describes fifteen pairs of cutaneous glands in the larva of *Bombyx*. In the thorax there are two pairs to each ring, one set lying slightly in front of or above the stigmata, the others at the external base of the appendages. There are nine pairs in the abdomen with somewhat analogous positions. In the larva about to be hatched the glands measure only 0·02 mm. by 0·03 mm., but in later stages a maximum diameter of 3 mm. may be attained.

A well-developed gland has an ample cavity, containing some granular material, surrounded by a broad spongy cortex, and leading into a short excretory canal with a large covering cell or with several. In the young larva, however, the future glands are seen to be true cells with large nuclei, and Verson maintains that the cortex of the gland is derived from the protoplasm of the primitive cell, while the cavity

* Zoolog. Jahrb., v. (1890) pp. 281–343.
† Bull. Soc. Entomol. Ital., xxii. (1890) pp. 3–29 (4 pls.).

represents the degenerated nucleus. The spongy cortex is a most notable illustration of that vacuolated structure of protoplasm which Bütschli has described in Protozoa. In the period of activity the products accumulate in the vacuoles, they assume firmer consistence, they are incorporated into the original plasma, and the whole structure swells.

As to the function of these curious glands, it must be noted that they never communicate with the free surface of the silkworm, but that their products have to expand between the hypodermis and the cuticular husk. Prof. Verson shows that these glands, besides facilitating the detachment of the older cuticular husk, function actively and as it were vicariously when the Malpighian tubules are temporarily out of function, and form material which yields on evaporation crystals of oxalate of lime and uric acid—in other words, an excretion like that of the renal tubules.

Evolution of the Hymenoptera.*—Prof. F. Delpino suggests the following scheme of development of the families of Hymenoptera, partly derived from that of the plants on which they feed:—(1) *Tenthredinideæ*, or phyllophagous Hymenoptera; (2) *Siricidæ*, or xylophagous Hymenoptera (contemporaneous with the evolution of the Coniferæ); (3) *Ichneumonidæ*, or pupivorous Hymenoptera; (4) *Fossori;* (5) *Vesparii;* (6) *Apiarii;* (7) *Formicarii.* In this series the biological advances *pari passu* with the morphological evolution. The Siricidæ are all more or less gluttonous of honey. The evolution of a long oviduct advances from the Siricidæ to the Ichneumonidæ; the conversion of this oviduct into a poisonous sting takes place between (4) and (7). The property of pupivorous larvæ connects (3) and (4). The nidifying character connects (4), (5), (6), and (7). The property of socialism connects (5), (6), and (7). The character of producing different castes connects (6) and (7). According to this scheme the family of ants represent the most recent evolution of the Hymenoptera.

Monograph of Sand-Wasps.†—Herr A. Handlirsch publishes the fifth part of his monograph on sand-wasps, including a systematic study of the American genus *Monedula*, in which he distinguishes 44 species, half of them new.

Development of Hydrophilus piceus.‡—Dr. K. Heider makes a reply to the criticisms of Prof. Graber, § in which he urges that much of his work was done before his critic published the results of his studies; some of the points referred to are merely petty, and were not judged to be worth special notice.

Development of Platygaster instricator.‖—Mr. N. Kulagin has made a study of the eggs laid by this parasitic insect in the larvæ of Cecidomyidæ. The species examined was found to lay from two to five eggs in a cocoon, and these eggs are either not simultaneously developed or some only undergo development. The blastoderm is formed of elements of the division which extends in regular order from the centre to the periphery of the egg; the other elements of division remain in

* Malpighia, iv. (1890) p. 7.
† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 77–166 (1 pl.).
‡ Zool. Anzeig., xiii. (1890) pp. 428–30.
§ See this Journal, *ante*, p. 451. ‖ Zool. Anzeig., xiii. (1890) pp. 418–24.

the interior of the egg and form the endoderm. The larvæ differed in some points from those described by Ganin. These larvæ do not essentially differ from those of other orders.

Pupal Stage of Culex.*—Dr. C. H. Hurst gives a description of the pupal stage of the Gnat. The pupa does not eat; it floats, throat upwards, by virtue of a large air-cavity which lies under the hinder part of the thorax and the anterior part of the abdomen; in the abdominal part of the cavity there is, on either side, a large stigma which is held open by a fairly well developed cuticular lining and guarded by numerous spines. The cavity and stigmata are mainly, if not exclusively, hydrostatic in function, and serve not only to make the pupa float when at rest, but to make it float in a definite position with the thorax upward and the apertures of the respiratory siphons at the surface of the water. The pupæ seem to be affected not by noise, but by tremors of the water, and the organs by which these movements are felt are probably the setæ on the first segment of the abdomen.

A detailed account is given of the external characters of the pupa. The alimentary canal has no convolution, except in the region of the intestine. At first the general structure is that of the larva, but during the pupal period great changes occur. The most striking is the reduction in thickness of the epithelium, which is best seen in the stomach; changes of form occur in various parts of the alimentary canal.

Three layers were recognized in the wall of the heart—an endocardium, which is an exceedingly thin layer of flat cells, with conspicuous nuclei; a middle layer which consists of encircling fibres, probably muscular; and an outer fibrous layer, the fibres of which are mostly longitudinal in direction. The author denies the existence of the tracheal gills of Palmén.

The nervous system is remarkable for the fact that, in the space of four days, certain ganglia increase enormously in size by the addition of cells, apparently derived directly from the epidermis; while other ganglia, already well developed and functional, shift bodily from their original positions, and in some cases fuse with ganglia originally remote from them. A careful account is given of the formation of the large hemispherical basal joint of the antenna of the imago.

The prostatic glands, though apparently simple, are seen in section to be double, though the cavities communicate posteriorly before opening into the common pouch; this last is a dilatation of the ejaculatory duct at the base of the copulatory organ. The median oviduct is formed by invagination in what seems to be the ninth sternum, and as the anus opens lower down, there is no common cloaca. The author promises to work out in detail the development of the eye.

Hermaphrodite Rudiment of Gonads in Male of Phyllodromia (Blatta) germanica.†—Herr R. Heymons gives an account of some points in the history of the formation of the genital organs in the male of this insect. They first appear at a very early stage in development, for genital cells are to be seen in the germ-stripes which show the

* Studies Biol. Lab. Owens Coll., ii. (1890) pp. 47–71 (1 pl.).
† Zool. Anzeig., xiii. (1890) pp. 451–7.

first signs of segmentation. The author cannot confirm the statement of Cholodkovsky that the genital cells have their origin from yolk-cells.

When the first sexual differences become apparent, the genital rudiment of the female consists of a right and a left elongated cord of cells which, even in the embryonic period, becomes converted into numerous separate ovarian tubes. The almost universally accepted doctrine that epithelial cells and eggs are only modifications of primitively similar elements is not true of *Phyllodromia.* While the genital rudiment of the female is completely converted into the ovary, that of the male is only partly converted into the testis. At the time when sexual differentiation commences, the male rudiment consists of cord-like structures which extend, right and left, from the second to the fifth abdominal segment. Each genital rudiment consists of genital and epithelial cells; the greater number of the latter have the form of elongated cells on the ventral side of the rudiment, and form the anterior widened part of the vas deferens. The genital cells are not regularly distributed within the rudiment, but are collected into larger numbers at four points. These are the first signs of the four testicular follicles of which the gonad of either side consists. Part of the genital rudiment is now seen to consist of the four follicles which are directly connected with the elongated cells that form part of the vas deferens, in a ventral direction only. They have, therefore, no connection with the terminal plate. The second part of the rudimentary gonad consists of those genital and epithelial cells which have not taken part in forming the testicular follicles, and they are directly connected with the terminal plate. By the contraction of the efferent duct the testicular follicles become to some extent pushed out from the genital rudiment and lie below and behind it. That part of the genital rudiment of the male which is not used in forming the testicular follicles may be seen to represent the rudiments of a female gonad; in some cases this is developed so far that both egg-tubes and separate ova become developed; but this female organ has no direct connection with an efferent canal. The presence of this arrangement in so archaic a form seems to prove that the ancestors of insects were hermaphrodite.

Respiration of Decticus verrucivorus.*—M. C. Contejean has studied the mode of respiration of this Grasshopper. He finds that the abdomen alone effects the respiratory movements. Inspiration is passive and is due to the elasticity of the parts of the exoskeleton and to the reaction of the viscera. Expiration is active and lasts longer than inspiration. The respiratory movements increase in frequency with the activity of the animal, and their number is increased by the heat and irritability of the insect. Removal of the head does not put a stop to respiration, the rhythm of which is scarcely slowed. If the abdomen is divided into several parts, each breathes separately. From the experiments made by the author on the influence of the nervous system, he is led to conclude that the lower part of the cord is not sensory and the upper part motor as Faivre has demonstrated for *Dytiscus.* This would show that the organization of the Orthoptera is less elevated than that of the

* Comptes Rendus, cxi. (1890) pp. 361–3.

Coleoptera, a result which seems to be confirmed by the habits of the two groups and their order of appearance in time.

Development of Embryo of Locustidæ.*—Mr. W. M. Wheeler has a preliminary notice of the development of *Xiphidium ensiferum*. The eggs are laid under the scales of galls produced by *Cecidomyia salicis-gnaphaloides*. They are about 5 mm. long and are slightly curved, the convex side being the ventral and the sharper end the cephalic part of the egg. The author states that this differentiation in the form of the egg is of great importance for a correct understanding of its development. The small ventral plate is formed by the parting of the blastoderm cells in the middle of the convex side of the yolk. The very delicate gastrula-groove soon becomes apparent, and at the same time a rounded cellular disc is seen in the middle line in front of the cephalic lobes. This disc is called by the author the preoral plate, and it arises as an independent and isolated centre from the blastoderm by the conversion of a number of flattened cells into closely packed columnar and spindle-shaped elements. The organ does not, therefore, differ from the ventral plate in its mode of origin.

The preoral plate seems to early lose its independence, as it becomes connected with the head of the embryo; it comes to lie between the two cephalic plates. When the embryonic coverings are formed the plate is shut out, although the two cephalic lobes are included in the process.

The author describes the successive stages of development; at last the yolk is found to be surrounded by chorion, yolk-membrane, primary serosa, secondary serosa, secreted layer, cuticle, tertiary serosa, and amnion; later on a larval membrane is added.

The author has not been able to find any description of an organ which can be thought to agree with the preoral plate of *Xiphidium*, but the Crustacea, and especially the Isopoda, have in the dorsal organ a structure which has a certain similarity to this peculiar embryonic organ. If we go beyond the Arthropoda we find in the prestomium of Annelids an organ which at first sight has a resemblance to the preoral plate; but when the whole development of the structure is studied not much support is to be found for such a view. It is possible that in other Locustidæ the organ will be discovered to be more completely retained than in *Xiphidium*.

Leaf-winged Locust.†—Mr. J. J. Quelch describes some remarkable cases of protective colouring in *Pterochroza* and allied forms. The wings are ovate and one side is somewhat wider than the other, according to the depth of the curve of the central vein which is thickened like a mid-rib. From this pass off side veins which branch and reticulate just as in the case of the leaf of a dicotyledonous plant. In one species the shade varies from reddish brown or yellow to a dull purple, and closely resembles the shades to be found on the young leaves of many of the forest trees, and more especially of *Mora excelsa*. In another the tint is deep green, but seems to fade on continued exposurs to light after the death of the insect. In a third it is of a very pale yellowish brown, much like

* Zool. Anzeig., xiii. (1890) pp. 475–80.

† Journ. Roy. Agricult. Soc. Brit. Guiana, 1890, p. 141. Ann. and Mag. Nat. Hist., vi. (1890) p. 275.

the colouring on an old and fading leaf about to fall from the plant; while in a fourth it is a dull, dead brown, like that of a fallen leaf. We require to know much more about the history and habits of these forms which, perhaps, are not rare, but are only accidentally discovered, in consequence of their special coloration.

Living Fly Larvæ in the Stomach and Mouth.*—Herr H. Senator relates the case of a patient who spat out about a dozen still living larvæ, which on examination seemed to be those of the common house-fly. How the ova or the larvæ had been introduced was inexplicable, and as the maggots died, the adult insect could not be exactly determined.

Coloration of Silk by Foods.†—M. L. Blanc finds that some colouring matters, which are very soluble and very diffusible, such as fuchsin, can be absorbed by the intestinal epithelium of the silkworm; these substances may then colour the cells of the silk-secreting organs, but they do not colour the product of secretion.

δ. Arachnida.

The Wolf-spider and its Cocoon.‡—Dr. W. Henking has watched and experimented with *Lycosa amentata* and *Tarentula clavipes*, in order to discover the exact relations between the female and her cocoon. It is well known that mother-spiders guard the cocoon with great care, yet experiments show that this does not depend upon the presence of young in the cocoon, but on its "odour" (?) and definite weight. That odour is one of the credentials is an inference, in regard to which Dr. Henking repeatedly says that he is only prepared to maintain that the spider has some discriminating sensitiveness nearer to smell than to any other human sense. A false cocoon with any sort of contents or with any kind of surface will be carried about by the deluded parent provided that the aforesaid odour be detected. A portion of the genuine envelope is sufficient to render a foreign body acceptable. On the other hand, after carrying an artificial cocoon for a while the spider will throw it away, and this Henking regards as deliberate. Nor has he any doubt as to their memory, for spiders seek patiently for a lost cocoon, and recommence the search even after prolonged interruption. Moreover, they seem to have an instinctive feeling when the hatching of the young is about to occur, and will dip the cocoon in water, as if to hurry the young out. The visual power is regarded as slight, but the tactile and auditory senses are acute. The formation of the cocoon and many more general facts in the life of these spiders are graphically described.

Gall-mites.§—Dr. A. Nalepa continues his systematic study of gall-mites or Phytoptidæ, describing and figuring 12 new species of *Phytoptus*, and 4 of *Phyllocoptes*. In a list of all the forms which he has described, we find 29 species of *Phytoptus*, 7 of *Cecidophyes*, 11 of *Phyllocoptes*, 1 of *Acanthonotus*, and a note of the plants on which they live and of the malformations which they cause. It is generally true that different forms of Cecidia are at once referable to different mites, but Nalepa

* Berlin. Klin. Wochenschr., 1890, No. 7. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 150–2.
† Comptes Rendus, cxi. (1890) pp. 280–2.
‡ Zool. Jahrb., v. (1890) pp. 185–210.
§ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 40–69 (7 pls.).

finds some curious exceptions. Herbaceous plants usually harbour only one species of mite, but trees and shrubs almost constantly shelter several. The suggestion of Thomas that there were some free-living Phytoptidæ is confirmed by the strongly developed integuments in the species of *Phyllocoptes* and *Acanthonotus*, and especially by a species of *Phyllocoptes* (*P. schlectendali*), which Schlechtendal found living freely and producing white spots on the leaves of *Pyrus malus*.

Acarina from Algeria.*—Mr. A. D. Michael reports on 44 species of Acarina obtained during a recent visit to Algeria. A second species of the remarkable genus *Cæculus* was discovered, which was noticeable for its size and for the singular arrangement of the hairs on the cephalothorax. *Notaspis burrowsii* sp. n. affords an example of the very wide distribution of these minute creatures, as it has also been obtained in Canada. *Damæus phalangoides* sp. n. has such very long and slender legs that one wonders, when the extreme brittleness of the chitin in this family of Acarina is borne in mind, how they can remain unbroken. *D. patelloides* sp. n. is remarkable for having a pyramidal abdomen. While *Nothrus sylvestris* has the claws monodactyle, the Italian *N. ananniensis* has them didactyle; a variety of this latter, found in Algeria, is tridactyle.

Ontogeny of Limulus.†—Dr. J. S. Kingsley has a preliminary notice of his studies on the development of the King-crab. The result of yolk-segmentation is to divide the egg into a number of yolk-cells, in the centre of each of which there is a nucleus with a thin layer of protoplasm. As the result of migration a blastoderm is at first formed on one side of the egg, the cells of which are smaller and less charged with yolk than those of the rest of the ovum. This blastoderm produces a lighter spot on one side of the egg which strikingly resembles the primitive cumulus of Arachnids. In its centre there appears a small circular pit, which is to be regarded as the blastopore. A second cloud appears behind the first, and soon surpasses it in size. No endoderm is produced by gastrulation.

In fifteen days the germinal area becomes divided by the appearance of a transverse groove into cephalic and postoral plates, and in twelve hours more a second groove appears behind the first, and cuts off a narrow ridge, which is the first postoral somite. Successive somites are added by budding from the caudal until six are formed. Near the outer margins of each of these paired thickenings the rudiments of legs arise. And, almost simultaneously, paired thickenings for the nervous system appear, one in each somite of the body and three in the cephalic plate. A few days later a series of six pairs of segmentally arranged sensory thickenings arise outside the legs; these have different fates. The first gives rise to the median ocelli of the adult; the second to a peculiar and as yet undescribed sense-organ, which occurs on the thin skin just in front of the first pair of appendages; the third soon disappears; the fourth forms the dorsal organ of Watase; the fifth gives rise to the paired compound eyes, and the sixth pair is evanescent. These organs are connected with one another and with the brain by a longitudinal

* Proc. Zool. Soc. Lond., 1890, pp. 414–25 (2 pls.).
† Zool. Anzeig., xiii. (1890) pp. 536–9.

nerve, which takes an undulating course between the organs and the bases of the legs.

There is a precocious separation of ectoderm and endoderm (yolk-cells) during the formation of the blastoderm. The endoderm retains its primitive character as a solid mass of long yolk-cells until the caudal spine appears. The yolk-cells are not true vitellophags; they metabolize the yolk which is contained in each, but the cells themselves are directly converted into the living epithelium of the mid-gut.

In embryos at the time of hatching the sternal artery has arrived at the condition found in the adult scorpion; it consists of a tube which lies on the upper surface of each half of the œsophageal nerve-ring. It is not till much later that it obtains the investing character of the adult. Packard's brick-red gland is of mesodermal origin; it contains in its interior the cavity of the fifth postoral somite; it soon becomes folded on itself and the region of the bend grows rapidly forwards. The outer limb of the fold becomes folded at four points and these new bends grow out in each body-segment, giving rise to the lobes which are characteristic of the organ in the adult. With the folding there is a good deal of fusion of the walls, and this is followed by perforations, the result of all of which is the peculiar anastomosing structure of the adult organ. The author thinks he has afforded further evidence of the close relationship between Arachnids and *Limulus* and reasons for removing the Merostomata more widely from the Crustacea.

ε. Crustacea.

Excretory Apparatus of Decapod Crustacea.*—M. P. Marchal, in continuation† of his studies on the excretory apparatus of Decapod Crustacea, describes that of *Homarus vulgaris*. The antennary gland is large and heart-shaped; the saccule has a cavitary system composed of elegant ramifications which radiate around its orifice. The orifice itself is bordered by clear cells which are very high, and it leads into the second portion of the gland which may be called the labyrinth; this is large and is divided into two lobes forming a U, the outer branch of which communicates with the saccule. The labyrinth is formed of a number of extremely fine canaliculi which anastomose with one another in all directions and so form a close spongy tissue, the innumerable lacunæ of which are invested by an epithelium of striated cells, covered by a cuticle.

In *Palæmon serratus* the saccule is small, reniform, and independent of the rest of the gland, with which it is connected only at its point of communication; its cavitary system is formed of a central space and of short areolar diverticula which are given off from it. The orifice of communication is wide, and bordered with very high granular cells. The labyrinth forms a spongy, rounded mass. The two bladders have numerous prolongations which ramify among various organs. In front of the stomach they unite to form an unpaired suprastomachal bladder which has the form of an elongated sac with smooth walls.

In *Pagurus Bernhardus* the saccule is ramified, and there is the same difference between it and that of the two preceding types as there is

* Comptes Rendus, cxi. (1890) pp. 458-60. † See *ante*, p. 324.

between the lung of a Reptile and that of a higher Vertebrate. Of the prolongations given off from the bladder one is of special interest as it descends along the intestine and unites with its fellow of the opposite side to form an enormous unpaired abdominal bladder.

In *Galathea strigosa* the gland is deeply divided into several lobes, which are themselves broken up into several secondary lobules; the saccule has ramifications which are much more developed than those of *Pagurus;* the antennary gland has a structure very similar to that of *Galathea.* The bladder of the Brachyura is remarkable for its great size; in *Platycarcinus pagurus*, *Carcinus mænas*, *Xantho floridus*, *Portunus puber*, and others, there is an enormous hind-bladder which communicates with the rest by a narrow tunnel hollowed under the mobile insertion of the adductor of the mandible. In front there is a large suprastomachal paired lobe.

Metallic Brilliancy of Sapphirinidæ.*—Dr. H. Ambronn has investigated the causes of the metallic brilliancy of the Sapphirinidæ, on which Gegenbaur, Claus, and Haeckel have already written. He came to the conclusion that he had to do with the interference colours that appear in very thin layers. There appears to be a layer in which are closely set uniaxal anisotropic structures which are perhaps true crystals. The dimensions of these vary in various species; in *Sapphirina fulgens* they have a transverse diameter of about $0 \cdot 8–1\ \mu$, while the long diameter is $1 \cdot 3\ \mu$; in a form allied to *Sapphirina pachygaster* the dimensions are somewhat greater. But as these sizes are too great it is necessary to suppose that between the chitinous investment and the layer of prisms there is a layer of slight refractive power which cannot be morphologically distinguished; the layer of prisms would then increase the intensity of the colours by acting as a strongly reflecting layer. Observations show that the colours are not the spectral colours of a grating.

Minute Structure of Eye of Arcturus.†—Mr. F. E. Beddard gives descriptions of the minute structure of the eye in some shallow-water and deep-sea species of this genus of Isopods. He finds that all the shallow-water species examined have lenses which are perfectly clear and transparent and are characteristically pear-shaped. On the other hand, all those species which appear to have a partly opaque lens are deep-sea forms, and in some there is a reduction in the size and an alteration in the shape of the lens which may be thought to impair its perfection as an organ for the passage of rays of light. Another point of considerable importance in relation to the supposed degeneration of the eye is the smaller amount of pigment which is found in the eye of most of the deep-sea species that were examined by the author.

Development of Amphipoda.‡—In the fourth of her studies Madame Marie Rossiiskaya-Koschewnikowa describes the development of *Sunamphitoë valida* and *Amphitoë picta.* The former does not differ from other Amphipods in the mode of formation of its germinal layers

* Mittheil. Zool. Stat. Neapel, ix. (1890) pp. 479–82.
† Proc. Zool. Soc. Lond., 1890, pp. 365–75 (1 pl.).
‡ Bull. Soc. Imp. Nat. Moscow, 1890, pp. 82–103 (2 pls.).

and in many points it resembles *Gammarus*, while the mode of development of its digestive tract is similar to that of *Caprella*. The history of *A. picta* has already been worked at by Rathke, who does not, however, make any mention of its dorsal organ; on the whole, its history is very closely similar to that of *S. valida*.

Addendum to Monograph of Caprellidæ.* — Dr. P. Mayer has published an addendum to his monograph of Mediterranean Caprellidæ. A large portion consists of systematic work, in which several new genera and species are described. In the anatomical and histological portion some space is given to the appendages, while the phylogenies of the Cyamidæ and of the genera and species of the Caprellidæ are briefly discussed.

Cladocera of Neighbourhood of Moscow.†—Mr. P. Matile has a memoir on the Cladocera found in the neighbourhood of Moscow, in which he enumerates seventy-five species, a few of which are new; this is a considerable increase on the forty-three species reported by the three naturalists who have before written on this subject.

New Cypridinidæ.‡ — Dr. G. W. Müller describes some new Cypridinidæ collected by Hilgendorf on the coast of Japan, and by Chierchia on the cruise of the 'Vettor Pisani.' Most of the members of this family of Ostracods frequent the sea-bottom at slight depths, though at times they may swim on the surface. But a number of species of *Cypridina*, grouped by the author in the subgenus *Pyrocypris*, are markedly pelagic, luminous, and strong in numbers. These surface-forms swallow Radiolarians, Infusoria, minute Heteropods, &c., and their œsophagus must be very extensile; those which frequent the bottom eat diatoms and small organisms. After describing the shell and the appendages, Dr. Müller proceeds to the systematic part of his memoir, where he describes one new species of *Cypridina*, six within his new subgenus *Pyrocypris*, two of *Philomedes*, four of *Asterope*. Some of these species are brightly phosphorescent, and there is some evidence to show that the luminous material is exuded from glands on the upper lip.

Halocypridæ.§—Dr. G. W. Müller describes the Halocypridæ of Chierchia's collection. They are pelagic in habit, though *Conchœcia variabilis* extends from the surface to a depth of 2000 fathoms, and they are among the swiftest entomostracan swimmers. The very uniform shell, the abundant glandular cells usually confined to the shell margin, and the appendages are described at length. Four genera are recognized:—*Halocypris* Dana (1 sp. n.), *Halocypria* Claus, *Conchœcia* Dana (6 sp. n.), and *Euconchœcia* g. n.

* 'Fauna u. Flora des Golfes von Neapel,' xvii., Berlin, 1890, 157 pp. and 7 pls.
† Bull. Soc. Imp. Nat. Moscow, 1890, pp. 104-69, 3 pls.
‡ Zool. Jahrb., v. (1890) pp. 211-52 (3 pls.). § T. c., pp. 253-80 (2 pls.).

Vermes.

a. Annelida.

Descent of Annelids.*—Herr E. Meyer makes this essay a text for some remarks on the origin of metamerism and the significance of the mesoderm. Claus has recently suggested that the jointed Cestoda may be derived from the unsegmented forms owing, primarily, to the metameric repetition of the gonads. The author believes that an analogous process is the cause of the metamerism of the body of Annelids; though it never produces complete individualization of the segments, it does in some cases lead to asexual reproduction by division.

The ancestors of the Annelids appear to have been strong, predatory Turbellaria which lived a pelagic life. Their body was elongated, and they may have had some resemblance to the Nemertines, which, however, were not their ancestors, for they form a distinct side-branch. The gonads were placed in the body-parenchyma, which was partly surrounded and partly traversed by muscles, and were, in the young, a single pair of compact cell-cords, but in the adult long hollow tubes opening at the hinder end of the body by a pair of simple dermal pores. It is conceivable that these tubes, when filled with sperm or ova, would affect the flexibility of the whole body; this may have led to the two tubes being broken up into two rows of metameres of equal size. They would naturally become centres of metamerism, around which the other organs, diffused and scattered through the body, would become metamerically grouped. This grouping would affect the spaces in the parenchyma, and so would give rise to the paired and segmentally chambered secondary body-cavity.

The extension of the gonads would cause the filling up of a large part of the primary cœlom, which in the ancestors of Annelids was probably an irregular system of lymph spaces and ducts; only a small portion would, therefore, remain over to form the definite blood-vascular system. The author offers the following hypothesis with regard to the origin of the neural and hæmal longitudinal muscular areas. Some of the non-productive elements of the walls of the gonads may be looked upon as epithelio-muscular cells, the distal fibrillar portions of which became drawn out into two ends; these fibrillar parts, by their contractions, exerted a pressure on the contents of the follicular cavities, and were, therefore, primitively of use in ejecting the generative products. When the walls of the follicles became attached to the integument and enteron, the fibrils lost their function and disappeared, except in the longitudinal areas of the outer body-wall, where they at first strengthened the primary longitudinal musculature, and subsequently completely replaced it. The author further developes the consequences of this change.

Herr Meyer holds to the opinion that the nephridial tubes should be regarded as parts of a pair of longitudinal canals, such as are possessed by the Turbellaria; the presence of intersegmental constrictions of the body hindered the flow of fluid and caused the formation of metameric orifices. The peritoneal funnels are neomorphs.

* Biol. Centralbl., x. (1890) pp. 296-308.

The definite nervous system is the direct descendant of the arrangement which obtains in the Turbellaria, but the whole larval system is a modification of a still older, primitively diffuse, subcutaneous plexus of nerve-cells. Similarly, the ciliated rings have not the significance which is so frequently attributed to them, but, like the larval form itself, are a secondary peculiarity necessary to a pelagic mode of life.

Although the setal apparatus is characteristic of Annelids, there are in the Turbellaria similar though superficially placed dermal structures, as, for example, in the *Enantia spinifera* described by Graff. The true chætopodia may have been derived from such primitively irregularly arranged dermal weapons. The cephalic tentacles and trunk cirri appear to be outgrowths of specially sensitive parts of the integument, the entrance of blood-vessels into which would give rise to gills.

The conception of Annelid ancestry held by the author has a distinct bearing on the morphology of the mesoderm. If the peritoneal sacs of Annelids, with all their derivates, are to be derived from the gonads of their ancestors, then the secondary or cœlomatic mesoderm of all Metazoa that possess it must have the primitive significance of a gonidial tissue. The primitive gonad-cells formed the rudiments of the secondary or cœlomatic mesoderm, and these do not really belong to either of the two primary germinal layers, but are, for a time, intercalated between the elements of one or other layer, at the beginning of the ontogenetic development of the Metazoa. The author does not regard the embryonic mesenchym as a single structure, but rather as the sum of the undifferentiated rudiments of various organs and tissues, which were primitively quite independent of one another.

Australian Earthworms.*—In the sixth of his communications on Australian earthworms Mr. J. J. Fletcher describes eight new species, treats a number of small perichæte worms as varieties of species previously described, and gives further information as to four known species. As in earlier papers, the question of generic distinctions is postponed for the present. With *Cryptodrilus* are associated *fasciatus*, with a robust body transversely striped; *Smithi*, in which there is an exaggerated condition of the dorsal situation of the outer couple of setæ of each side, *Tryoni*, *semicinctus*, and *simulans*; the affinities of the last two are not quite clear. *Acanthodrilus Macleayi* is not more than 27 mm. long; the new species associated with *Perichæta* are called *macquariensis* and *terræ-reginæ*. Two new varieties of *Cryptodrilus saccarius* are described.

New Genus of Eudrilidæ.†—Mr. F. E. Beddard has a preliminary note on a new genus of Eudrilidæ, which he calls *Hyperiodrilus*. It comes from West Africa, and is most nearly allied to but distinct from *Stuhlmannia*. The setæ are in couples, but the dorsal are closely approximated, while those of the ventral couple are far apart. There is a protrusible penis, which is connected by two grooves with two prominent papillæ. The most interesting organs from a structural point of view are the generative. As in *Teleudrilus*, the funnels of the four vasa deferentia lie in the interior of the sperm-sacs; the ducts open into a

* Proc. Linn. Soc. N.S.W., iv. (1890) pp. 987-1019.
† Zool. Anzeig., xiii. (1890) pp. 561-3.

large glandular atrium which is tubular in form and much like that of *Acanthodrilus.* Each ovary is inclosed in a separate cœlomic sac, which contains a portion of the nephridium belonging to its segment; the two ovarian sacs communicate with each other by a narrow tube-like sac, and also with a large sac which forms a complete ring encircling the œsophagus, and is continued into an extensive sac passing along the dorsal surface of the intestine into the fifteenth segment. The bursa copulatrix is a small globular sac from which arises a slender spermatheca with very muscular walls; this spermatheca is entirely inclosed by the left-hand portion of the periœsophageal ring and ends blindly in the interior of that cœlomic space.

β. Nemathelminthes.

New Species of Strongylus from Paunch of Ox.*—Dr. R. Ostertag has a preliminary notice of *Strongylus convolutus* sp. n., found in the paunch of a young bull. It was present in considerable numbers and seemed to have caused considerable disturbance of the nutrient processes. The parasites are small (male 7–9, female 10–13 mm. long), and of a yellowish-brown colour; the colour is due to small pigment-grains in the intestine. The form is said to be distinguished by its simple structure, the two glandular organs near the commencement of the enteron, and the bell-like dermal fold over the vulva.

γ. Platyhelminthes.

Northern Turbellaria and Nemertinea.†—Mr. D. Bergendal has a preliminary notice of his studies on northern Turbellaria and Nemertinea. *Uteriporus vulgaris* is the name given to a form which in external appearance has considerable resemblance to *Gunda.* The generic character appears to be the presence of an independent opening to the uterus which is placed near the orifice of the penial sheath. There is a small depression around the genital orifices. The oviducts unite behind the penis into a common duct which runs forward and opens into the cavity of the penial sheath. The arrangement of the organs is almost segmental, it being very rare to find more than one testis in each septum.

A new genus must be made for a large Polyclad which is like *Cryptocelis;* it is distinguished chiefly by the strong muscular glands which lie in a special cavity behind the separate genital orifices. The author proposes to call the form *Cryptocelides Loveni.* About thirty species of Nemertinea were observed in Bohuslan, some ten of which seem to be new; two of the more interesting are parasitic, one living in *Esperia lingua* and the other in *Phallusia mentula.*

Amphibdella torpedinis.‡—Sigg. C. Parona and A. Perugia make some additions to our knowledge of this parasite of *Torpedo narce.* The length of sexually mature forms varies between 1·5 and 5 mm.; as in *Gyrodactylus elegans* the anterior end bears a number of dermal glands; the oral orifice is ventral and lies in a sucker-like organ; the œsophagus

* Centralbl. f. Bakteriol. u. Parasitenk, viii. (1890) pp. 457–60.
† Öfv. K. Vet. Förhand., 1890, pp. 323–8.
‡ Ann. Mus. Civ. Genova, xxix. (1890) pp. 363–7. See Centralbl. f. Bakteriol., viii. (1890) pp. 335–6.

soon bifurcates. What have previously been taken to be testes are now recognized as pyriform dermal glands which are connected with two large excretory canals which open at the hinder end of the body. In the anterior region there is a large spherical or oval testis, from which a short vas deferens leads to a small penis. The oviduct forms numerous loops between the branches of the vitellarium. The hinder ends of this latter are not separated, but are united near the end of the intestine. The caudal end is divided into one unpaired median and two lateral lobes, which again are divided into five smaller lobules, each with a small hook. It is clear that *Amphibdella* has not, as Chatin, its original describer, thought, any relation to the Hirudinea, but that it is a true Trematode and belongs to the Gyrodactylidæ, where it stands between *Calceostoma* and *Tetraonchus.*

Helminthological Studies.*—Sig. P. Sonsino reports the occurrence of *Distomum hepaticum* in the nylghau (*Portax picta*) and in *Bos bubalus; D. caviæ* (?) from *Cavia cobaya; D. magnum* in *Cervus dama*, &c.; *D. lanceolatum* from *Antilope dorcas*, *Capra hircus*, and the ass; *Trichina circumflexa*, *Trichosoma* sp. (?), &c., from *Mus decumanus; Strongylus bifurcus* from several monkeys; *Distomum simile* sp. n. from *Python molurus; D. gelatinosum* from *Thalassochelys caretta;* three tailed species of *Distomum* (s. g. *Apoblema*), *D. excisum*, *D. rufoviride*, *D. ventricosum*, from fishes; besides *Anthocotyle merlucii*, *Pleurocotyle scombri*, *Octocotyle arenata* sp. n., *Trochopus longipes*, *Calceostoma elegans* from the same sources.

Structure and Development of Distomum cylindraceum.†—Dr. v. Linstow describes this well-known but very imperfectly investigated Trematode from the lungs of frogs. Its growth is very slow and apparently corresponds with that of its host. The mutual fertilization of two large specimens was observed, but self-fertilization seems also probable. The history of the reproductive elements was followed in detail, and some glimpse of the segmentation was obtained. The eggs pass into the alimentary canal of the frog and out by the cloaca, but Braun has also observed the passage of the entire *Distomum* through the amphibian's nose. In the latter case the parasites die in the water, while their eggs are liberated, and this also happens when female frogs die from the fatal effects of prolonged copulation. Three weeks after the eggs have reached the water, a ciliated sheath may be observed round the embryo, but several months pass before hatching occurs. The liberated embryo finds its way into *Limnæa ovata*, becomes a sporosac, and forms Cercariæ which leave their host about midsummer. These Cercariæ seem then to enter the larvæ of small beetles (*Ilybius fuliginosus*), and cysts containing them are found in the body-cavity of the adults. The beetles are eaten by frogs, and the cysts are dissolved in the stomach, whence the larval Trematodes migrate to the lungs or to other parts of the body.

Trematodes of Gills of Italian Fishes.‡—Sigg. C. Parona and A. Perugia have examined nearly one thousand sea-fishes, twenty per cent.

* Atti Soc. Tosc. Sci. Nat., vii. (1890) pp. 99–114.

† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 173–91 (2 pls.).

‡ Atti Soc. Ligustic. di Scienze Nat. e Geogr., i. (1890) 14 pp. See Centralbl. f. Bakteriol., viii. (1890) p. 310.

of which were found to have Trematodes on their gills. *Diplectanum æquans* and *Microcotyle sayii* were the most common. The *Gyrodactyli*, which are so common on fresh-water fishes, were represented only by *Tetraonchus van Benedeni*.

Cysticercoids Parasitic in Cypris cinerea.*—Mr. T. B. Rossiter describes the presence of cysticercoid parasites in *Cypris cinerea*. The head is about 3/100 in. in diameter, and the suckers are about 1/1000 in. wide and 1/800 in. long. The hooks are not unlike those of *Tænia nana* in their shape, and are not more than 1/1200 in. long.

δ. Incertæ Sedis.

Rotifer Parasitic on Vaucheria.†—M. F. Debray has followed out the life-history of *Notommata Werneckii* Ehrb., which he finds parasitic on *Vaucheria geminata*, *terrestris*, *pachyderma*, and *sessilis*, but not on *V. synandra*. After emerging from the egg within the gall, the young rotifer moves about freely for a time, finally escaping from the gall, and almost immediately again endeavours to effect an entrance into a *Vaucheria*-tube, rejecting all other algæ with which it may happen to come into contact. It at length pierces a tube and wanders about within it for some hours, until it finally settles itself in a gall. It here lays eggs of three different kinds; the first kind during the spring, with thin smooth membrane, followed by two other forms of lasting eggs with spiny membrane. The author has never seen the male rotifer, and believes that this production of eggs takes place parthenogenetically. After depositing its eggs, the rotifer dies and disappears almost entirely. The author dissents from Balbiani's view that the parasite inhabits only modified fertile branches of the *Vaucheria;* he regards the structures in which they are found as true galls, the result of injury to the tube caused by the puncture of the parasite.

Rotifers and Hepaticæ.‡—Prof. F. Delpino records the fact that a rotifer (named by Zelinka *Callidina symbiotica*) is commonly found in the drop of moisture retained by the recurved margin of the leaves of many Hepaticæ, and especially in the pitcher-shaped leaves of species of *Frullania*. No observations have, however, as yet justified the specific name.

Distyla and Cathypna.§—Mr. J. E. Lord suggests that the genus *Distyla* is identical with that of *Cathypna;* and that Mr. Gosse, to whom the latter genus is due, constructed it in mistake, through hurry and "failing powers," out of those specimens of the former genus which he happened to observe in a contracted state. Mr. Lord also gives drawings of two supposed new species of *Cathypna*, which he names *C. Gossei* and *C. Hudsoni*, and which he thinks that Mr. Gosse would have called *Distyla*, had he seen them only in their extended condition. On the point of classification raised by Mr. Lord, it is enough to say that Mr. Gosse's own descriptions and figures of *C. luna*, *C. sulcata*, and *C. rusticula* show that he had seen these creatures extended, and yet

* Journ. of Microscopy, iii. (1890) pp. 241–7 (2 pls.).
† Bull. Scient. France et Belg., xxii. (1890) (1 pl. and 9 figs.). See Notarisia, v. (1890) p. 1058. Cf. this Journal, *ante*, p. 643.
‡ Malpighia, iv. (1890) pp. 32–3 (1 pl.). § Science-Gossip, 1890, pp. 201–2.

considered that they ought to be separated from Eckstein's genus *Distyla*. And the distinction is plain enough: in *Cathypna* the whole trunk is loricated, and the creature, when extended, is dorsally arched; but in *Distyla* only the hinder portion of the trunk is loricated, the fore part having a membranous covering, and the creature when extended is comparatively flat, or, as it is termed, "depressed."

What Mr. Lord's species really are, or whether they are new, it is impossible to say from his imperfect figures and description; but it is easy to see how little competent he is to be a critic of the veteran naturalist, by turning to the Supplement of the 'Rotifera,' and comparing Mr. Gosse's last descriptions and drawings (done only a short time before his death) with those of Mr. Lord's in 'Science-Gossip,' remembering at the same time that Mr. Gosse's descriptions and drawings, in the Supplement, are of those very species which Mr. Lord says were hurriedly observed, and executed with "failing powers—of eyesight at least."

It is hardly necessary to point out the lack of taste and good feeling which leads Mr. Lord to quote scraps from the deceased Mr. Gosse's private letters, in order to help out an adverse criticism on his last work.

Cœlenterata.

Pelagic Anthozoa.*—Prof. E. van Beneden gives a preliminary notice of the results of his studies of the pelagic Anthozoa collected by Prof. Hensen. All were larval forms, and most belonged to the Cerianthidæ. From the abundance and variety of the pelagic larvæ it seems probable that the group is represented by very diverse forms at great depths; this fact is interesting, as the Cerianthidæ are very probably allied to the Rugosa. The special form to which the author calls attention is one which brings to mind the well-known larva of Semper; this form has never yet been subjected to a microscopic examination. The general form of the larva is pyriform, and the oral orifice is placed at the narrow end; the axis is that of the letter C, but it is probable that this shape is due to the action of the preservative fluid. The whole surface of the body is strongly pigmented, with the exception of a median band on the ventral surface; in the middle of this band there is a shallow groove. On the ventral surface there is a vibratile fringe, similar to that seen by Semper in his larva, and the cause of the marvellous iridizations which distinguish the creature. There is no trace of any tentacles around the mouth, and there does not appear to be any second orifice. Bilateral symmetry is obvious.

While in all known larvæ of Anthozoa the ectoderm has the same character all over the body, there is in this new form a sharply differentiated portion, which may be called the flagelliferous plate; the cells of which it is composed are exceedingly narrow and filiform, but there are never in it any glandular cells or any nematocysts; each of the flagellate cells has at its free end a small brilliant plate, which carries the flagellum. The cells are so disposed that the plate seems to form, at right and left, two pads which may be compared to those seen in the medullary plate of certain Vertebrates; in its centre is a widely

* Bull. Acad. Roy. Belg., lx. (1890) pp. 55–99 (1 pl.).

open groove, which in form recalls that of the medullary groove of higher Vertebrates.

The rest of the ectoderm, in stained specimens, breaks up into three differently coloured zones; in the outermost are a large number of nematocysts and of unicellular glands, while in the median the nuclei are very closely packed. Nervous elements could not be made out, but there is no doubt that they are among the various constituents of the ectoderm. The nuclei are larger than those of the flagellate cells, and show well-marked dots, the most apparent of which is, perhaps, the nucleolus. Some of the nematocysts are small, and have the form of cylinders, within which is a thread which describes an extremely regular spiral; others, which are larger, ovoid, rarer, and more deeply seated, have an irregularly arranged spiral. There are also two kinds of glandular cells; some are coarsely but uniformly granular, while others have clear contents and a homogeneous or reticulated appearance.

The mesenchymatous layer is remarkably thick, and contains a very large number of cellular elements. Some of the cells are large, and their protoplasm acts energetically on the colouring material; they may be rounded, fusiform, or stellate in shape. Others are much smaller and have always very fine and colourless prolongations. The new form is remarkable among Actinian larvæ for the constitution of its fundamental lamella, which is not simple, but is a well-characterized cellular tissue, while the differentiated cellular strata of endoderm and ectoderm, which are in immediate contact with it, have almost the appearance of the layer of osteoblasts of bony tissue, or the odontoblasts of teeth.

The cœlenteric cavity has about the middle of the long axis of the body the appearance of a transverse cleft; it is broken up at its periphery by three pairs of macrosepts, which have on their free edge a mesenteric swelling, into six spaces, the largest of which, in the transverse direction, is the medioventral. There are also six microsepts, the three pairs of which are unequally developed. The endodermal layer which lines the two surfaces of the mesenchymatous lamella of the mesenteries is delicate and formed of cubical cells, which are here and there replaced by fusiform elements. The mesenteric swellings exhibit no tendency to form convolutions; all the cells that compose them are conical and radiate in all directions around the slightly swollen extremity of the mesenchymatous layer.

In each macrosept a layer of longitudinal muscular fibrils may be seen in the form of a row of shining grains. The microsepts differ from the macrosepts in having their very short mesenchymatous layer almost reduced to the terminal enlargement of the macrosepts, in the delicacy of their endodermal layer, and the absence of the mesenteric swelling.

After describing the appearances of transverse sections taken at different levels, Prof. Van Beneden proceeds to point out the resemblances and differences between this new larva and that of Semper; the former are the general form of the body characterized by its considerable elongation, the existence of six well-developed sarcosepts, the total absence of any trace of tentacles around the mouth, and above all the presence of the median vibratile fringe; the latter are the cylindrical shape of one larva and the pyriform of the other, the difference in the

length of the fringe, which is shorter in the new larva, the absence in it of an aboral orifice, and the apparent differences in the characters of the nematocysts. After a careful review of the different possible groups with which this larva may be associated, the author concludes that it should be placed with the Zoanthinæ. These he regards as an independent branch, and cannot accept the recent views which would derive them from the Edwardsiæ. His opinions as to the affinities of some of the Anthozoa are shown in the following table :—

Zoanthinæ. Edwardsiæ.

Cerianthidæ. Hexactiniæ. Monauleæ. Gonactiniæ.

Paractiniæ.

Habits of Virgularia.*—Mr. E. Thurston, referring to recent doubts as to the truth of the statements that *Virgulariæ* stand up vertically with their bulb planted in the mud, and that they are able to pull themselves in with force, so as to nearly or quite disappear, draws attention to the statement made by his native diver. "The diver described the animals as sticking straight up in the sand, and said that, as soon as he touched them, they went deeper and deeper down in the sand, and sometimes fixed themselves so firmly that he could only secure them by digging them out with a spade."

Septal Budding in Recent Madrepores.†—Herr G. v. Koch corrects a passage in Neumayr's 'Stämme des Thierreichs' in which it is implied that septal budding does not occur in recent Hexacorallia. This mode of multiplication does still occur, especially in Astræeæ. It is illustrated by v. Koch in the case of *Favia*, and referred to as occurring in *Stauria*.

Symmetry of Hydroid-Colonies.‡—Dr. H. Driesch continues his studies on the arrangement of the "persons" in hydroid colonies, discussing *Plumularia*, *Aglaophenia*, and the Tubulariidæ. After arranging various Plumularians in a series according to their mode of ramification, he discusses the morphological value of the nematophores, and from his own point of view decides against their ranking as persons. From a technical study of Tubularians, he passes to some general notes on what he calls "comparative blastology" or the comparison of persons, and on the bearing of these studies in ramification on morphological problems.

Development of Hydra.§—Dr. A. Brauer has a preliminary notice of his studies in the development of *Hydra aurantiaca*. He finds that

* Proc. Zool. Soc. Lond., 1890, pp. 462–3.
† Morphol. Jahrb., xvi. (1890) pp. 534–6 (4 figs.).
‡ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 657–88 (6 figs.).
§ Zool. Anzeig., xiii. (1890) p. 457.

the polar globules are typically developed at the pole nearer the mother, as stated by Kleinenberg, and not on various points of the surface, as asserted by Korotneff. The granules in the globules are not yolk-spheres, but of nuclear origin. The equal segmentation leads to a blastula, which is composed of cells of equal and not unequal size. The cleavage-cavity is seen in the eight-celled stage. The endoderm is not formed by polar immigration of cells, but is multipolar; blastoderm-cells partly loose themselves from their connections and wander into the cleavage-cavity, partly undergo division, and the inner portions form endodermal cells. The ectoderm is not lost when the egg-shell is formed, but persists; the shell is a cuticular structure.

Porifera.

The Genus Stelletta.*—Dr. R. von Lendenfeld gives a monographic account of the genus *Stelletta*, describing five species, viz. *S. grubei*, *S. dorsigera*, *S. boglicii*, *S. pumex*, and *S. hispida*. They are "siliceous sponges, with triaen and amphiox megascleres, and with rigidly radial asters, with which rhabdodragmata are rarely associated; with small spherical ciliated chambers, and mostly with a rind." It may be noticed that the technical names of sponge-spicules have been recently † arranged, and the forms illustrated, by Prof. F. E. Schulze and Dr. Lendenfeld.

The peculiar "chones" which Bowerbank first noticed, and which Sollas first described with due carefulness, are discussed at some length. "In most Tetractinellids with thick rinds, and also in Monactinellids such as *Sollasella*, the pore-canals unite in groups into larger main-canals, which penetrate the rind. In the lower portion of the main-canal in these sponges there is a marked constriction which divides it into a distal portion (the inhalant main-canal) and a proximal portion (the chonal-cupola of the subdermal space). Sometimes, as in *Stelletta boglicii* and *S. hispida*, the constriction lies at the inferior end of the canal, where it opens into the subdermal space. In these forms the chonal-cupola is absent. The tissue which forms the constriction consists of flat, elongated, or in part spherical cells, forming a thick mass in the neighbourhood of the narrow chonal canal which passes through the constriction. These cells are more or less concentrically arranged, but in the Adriatic species of *Stelletta* there are not simple circular muscle-fibres, as Schmidt and Sollas maintained. As Auchenthaler correctly noted, they are cells which by their turgescence are able to narrow and close the chonal canal, and thus to regulate the stream of water."

Development of the Freshwater Sponge.‡—Dr. O. Maas finds that the egg of *Spongilla* is rich in yolk, that it undergoes total and equal segmentation, and gives rise to a compact morula. The cavity formed at one pole of this morula closes up before the cells have lost the character of blastomeres. The differentiation of the tissues begins simultaneously at all points of the embryo, and so gives rise to a trilaminate larva. The mobile larva consists of an outer layer, formed of cylindrical, ciliated cells; of an epithelial lining, formed of flat spindle-

* Abhandl. K. Preuss. Akad. d. Wiss., 1889 (1890) p. 75 (10 pls.).
† Op. c., i. p. 35.
‡ Zeitschr. f. Wiss. Zool., l. (1890) pp. 527–54 (2 pls.).

shaped cells, which invests the cavity with its duct-like outgrowths and adjoining flagellated chambers, which often extend as far as the innermost layer. This last consists of a cell containing still unused yolk, of a connective substance or mesogloea, in which there are cells and silicoblasts with their spicules. The larva becomes attached by the pole of its cavity, and undergoes an extraordinary amount of flattening; at the same time the cylindrical cells of the ectoderm become more and more flattened, while the cells of the marginal part become amœboid. As soon as the larva is flattened the flagellated chambers come near the surface, and the afferent orifices are formed by the ingrowth of the ectoderm-cells. The efferent system arises by the secondary breaking through of the primitive cavity to the exterior, while the subdermal cavities and the ducts which lead to the chambers are formed by later processes of growth.

Protozoa.

Parasites of the Blood of Birds and Tortoises.*—Herr B. Danilewsky has collected some of his observations on Hæmatozoa in two memoirs † on the comparative "parasitology" of the blood. Among birds, only the Passeres and the Raptores are known to be infected. In the red blood-corpuscles of owls Danilewsky detected *Polimitus sanguinis avium*, and saw it emerge equipped with several cilia from within the cells, though, like Pfeiffer, he regards this emergence as a result of the artificial conditions of his microscopic preparation. Fresh blood contains small spiral protoplasmic structures, which the author believes to be separated cilia of *Polymitus*, and it is possible that similar bodies in the blood of malarial patients, and even the *Spirochæta Obermeieri* of recurrent fever, may have a similar origin. Another curious form is *Trypanosoma sanguinis avium*, which, like Bütschli's Rhizomastigina, has the long flagellum of a Flagellate and the undulating contour of a Rhizopod. It divides longitudinally or transversely, or, rounding itself off, segments like an ovum into thirty-two coherent cells, which acquire flagella and then go apart. Though it is probable that this form may disturb the capillary circulation, and though others destroy the corpuscles, decisively morbid symptoms have not been detected in the host, thanks perhaps to the high temperature or to the inoculating influence of the constant presence of these parasites for generation after generation.

In the blood of tortoises the author describes a species of the flagellate genus *Hexamitus*, which probably passes from the food-canal to other parts of the body. The rest of the second memoir is occupied with an account of *Hæmogregarina*, which lives in the blood-corpuscles of *Emys*. It grows and forms spores, which burst into the fluid of the blood, and probably find their way into the hæmatoblasts. But the origin and complete history of this parasite are still obscure.

Dinobryon.‡—Dr. O. E. Imhof gives a summary account of what is known as to this genus of the Flagellata, ten species of which have been described; all of these are from Europe. Further forms will probably

* Biol. Centralbl., x. (1890) pp. 396-403.
† 'La Parasitologie comparée du Sang,' i. et ii., Kharkoff, 1889.
‡ Zool. Anzeig., xiii. (1890) pp. 483-8.

be discovered when a better survey has been made of freshwater lakes in other parts of the world.

Pigment and Conjugation of Euglena.*—Sig. O. Visart maintains that the red pigment (hæmatochrome of Cohn) of *Euglena sanguinea* has a close genetic relation to chlorophyll, and is probably a derivative thereof. As the red pigment occurs most abundantly at the maximum of light and heat, it seems reasonable to conclude that the intensity of the sun's rays is a factor in its formation. Sig. Visart has also observed and figured the conjugation of two individuals of *Euglena sanguinea*, and their ultimate fusion into a spherical cyst.

Monadine parasitic on Saprolegnieæ.†—Prof. M. M. Hartog gives an account of a monadine which he has observed in his culture of Saprolegnieæ. The mastigopod swarmer or zoospore stage may frequently be found in and about the infected hyphæ of old cultures about nine o'clock in the evening or later. It is from 7 to 10 μ long; each example has a nucleus of the rhizopod or myxomycete type—i. e. vesicular, with the nuclein in a spherical central mass, and there is at least one vacuole anterior to the nucleus. After a long period of active swimming, the parasites settle down on the walls of living hyphæ, glide along them like *Amœbæ*, and finally penetrate into them; the pseudopodia are now radiate and stiffish. After using up the nutrient protoplasm, that of the parasites becomes coarsely granular; the pseudopodia become retracted, and the granules are collected into a highly refractive excrementitious mass, surrounded by a clear vacuole and simulating a gigantic nucleus. These granules are obviously nitrogenous. The body of the parasite now becomes spherical. The nucleus gives rise to daughter-nuclei, and zoospores are, later, found. One bores through the cyst-wall, and the others follow through the same hole. The author calls this parasite *Pseudospora* (?) *Lindstedtii*, and, as its name implies, regards it as one of the Pseudosporaceæ.

Parasites of Malaria.‡—Prof. B. Grassi and Prof. R. Feletti, who have been prosecuting investigations on the parasites of malaria, support the views of those who are in favour of considering the appearances to be due to the presence of a microbe. They are of opinion that the forms described by Laveran, Marchiafava, Celli, and others are really the parasites of malaria, and that in all probability they are amœbiform Rhizopoda, and that there are two genera, *Hæmamœba malariæ*, associated with the regular type of malaria, and *Laverania malariæ*, found in connection with the irregular types of pyrexia. The observations of the authors confirm the actuality of the appearances insisted on by Laveran and others, and their views differ from those of their predecessors merely in their holding that the crescent-shaped bodies, called by them Laverania, and the amœboid pigmented forms (Hæmamœba) are representatives of two different genera, which when young are indistinguishable. Both are possessed of a nucleus which behaves, in reproduction, just as the nucleus of all other living beings does. Directly the plasmodium begins to grow the two genera show signs of difference,

* Atti Soc. Tosc. Sci. Nat., vii. (1890) pp. 92–9 (4 figs.).
† Ann. Bot., iv. (1890) pp. 337–46 (17 figs.).
‡ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 396–401, 430–5.

the amœboid passing through a resting form, while the crescentiform body soon assumes its characteristic shape.

With regard to the flagellate forms, the authors admit the reality of their existence, but are of opinion that they are involution or degeneration phenomena.

One experiment mentioned may be worth alluding to, à propos of the views of the writers. A person who had suffered for seven months of quartan ague and had recovered without treatment, was injected with 2 ccm. of blood from a patient ill for two months with *Laverania*, i.e. the blood contained many crescent-shaped bodies and few young Amœbæ. An attack of irregular fever followed, accompanied with the development of *Laverania*.

Micro-organisms intermediate between Animals and Plants.*— Mademoiselle Leclercq has published an interesting address under the above title, in which she gives a general sketch of the forms grouped under the head Protista. She concludes by giving reasons for believing in the immortality of protoplasm, and gives a notice of the lowest forms that exhibit the phenomena of death.

* Bull. Soc. Belge de Microscopie, xvi. (1890) pp. 70–131.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.

(1) Cell-structure and Protoplasm.

Structure of the Cell.*—Dr. C. Acqua has investigated some points connected with the growth of the vegetable cell, in the case of germinating pollen-grains (hyacinth, *Eschscholtzia californica*, *Clivia*). His observations led him to the conclusion that the new cell-walls are a direct product of the activity of the peripheral layer of protoplasm. In consequence of the rupture of the cell-wall, a portion of the protoplasm is forced out, and the portion that still remains inside breaks up into masses united by delicate protoplasmic filaments, which, after a time, become transformed into threads of cellulose. The increase in superficies was seen in many cases to take place by the distension and subsequent laceration of the old layers, while new layers become formed within, which, continuing to grow, are in their turn distended and lacerated. The increase in length of the pollen-tubes is entirely apical. When this growth takes place without interruption, the distension and formation of fresh cellulose may take place without any laceration.

As regards the part played by the nucleus, the author comes to the same conclusion as Palla,† that masses of protoplasm without any nucleus may form a new cell-wall. He was also able to demonstrate the possibility of maintaining the vitality of the nucleus for some days when entirely removed from the cell and completely isolated from the cytoplasm.

Movements of Protoplasm.‡—Ida A. Keller maintains that the currents of protoplasm so often observed in plants are not a normal phenomenon, but are a symptom of approaching death, and the result of pathological conditions. They may be caused by injury, by sudden and great changes of temperature, by the action of chloroform, by solutions of sugar and potassium nitrate, by absence of nitrogen, &c. In *Elodea canadensis* they are ordinarily observed in leaves which are beginning to wither, and do not cease until immediately before actual death. The author derived the same conclusion from the observation of leaves of *Trianea bogotensis* and *Butomus umbellatus*, leaf-stalks of *Alisma Plantago* and *Umbilicus horizontalis*, stems of *Tradescantia virginica*, air-roots of Orchideæ, tentacles of *Drosera*, seedlings of *Vicia Faba* and *Brassica Napus*, and hairs of *Tradescantia*, *Primula chinensis*, &c.

Callose.§—Under this term M. L. Mangin describes a substance which he believes to be an essential constituent of the cell-wall, although he has not at present been able to isolate it.

* Atti R. Accad. Lincei (Rend.), vi. (1890) pp. 577–9.
† Cf. this Journal, *ante*, p. 475.
‡ 'Ueb. Protoplasma-Strömung im Pflanzenreich,' Zürich, 1890, 47 pp. See Bot. Centralbl., xliii. (1890) p. 196.
§ Comptes Rendus, cx. (1890) pp. 644–7. Cf. this Journal, 1889, p. 538.

Callose is amorphous, colourless, insoluble in water, alcohol, or Schweizer's reagent even on addition of acids, readily soluble in a cold 5 per cent. solution of caustic soda or caustic potash, soluble in cold concentrated sulphuric acid, and in a cold solution of calcium chloride or tin chloride, insoluble in a cold solution of alkaline carbonates and ammonia, the latter giving it a gelatinous consistence. It is stained by anilin-blue and rosolic acid; the iodine-reagents colour it yellow. It is not a product of the decomposition of cellulose or pectic substances; its insolubility in ammonium-copper oxide, even after addition of acids, and its yellow colour with iodized phosphoric acid, distinguish it from the former; its insolubility in a cold solution of ammonia and of alkaline carbonates, and its resistance to the staining reagents of pectic substances, from the latter.

Callose is very widely distributed in the reproductive organs of Phanerogams and of Vascular Cryptogams; the author found it in the pollen-grains of Coniferæ, Cyperaceæ, and Juncaceæ, and in the plugs which interrupt the continuity of the pollen-tubes of *Plantago*, *Caltha* and *Narcissus*. In the vegetative organs of Phanerogams it occurs in the bast-tissue; elsewhere only occasionally, as accumulations in the interior of cells. In Fungi it plays a very important part, forming the membrane of the hyphæ and of the reproductive organs in the Peronosporeæ, Saprolegnieæ, Basidiomycetes, Ascomycetes, and some Saccharomycetes. It is found also in the membrane of the spores and sporanges of the Mucorini, in the mycelial filaments of the Polyporeæ, and elsewhere. In Lichens it exists in the membranes of the hyphæ, but not in those of the gonids. Among Algæ it is not nearly so widely distributed, but was detected in *Œdogonium*, *Ascophyllum nodosum*, and *Laminaria digitata*.

(3) Structure of Tissues.

Periderm.*—Sig. H. Ross adopts de Bary's definition of this term, viz. all the tissues which spring from the generating zone known as the phellogen, and von Höhnel's distinction of the three layers of which it is composed,—the outermost, *phellema*, composed of cork and phelloid; the innermost, *phelloderm*; while between them is the *phellogen*. The principal protecting element is the phellema, composed of a larger or smaller number of layers of cells with walls entirely, or for the most part, suberized. The phellema, like the epiderm, has no intercellular spaces except the lenticels, which here and there break the periderm, as the stomates do the epiderm, in order to allow of the escape of gases. The segmentation of the phellogen takes place in a radial or tangential direction, in five different ways, which are described at length.

The microchemical reactions for suberized cell-walls are described in detail, the best being concentrated sulphuric acid, which attacks all the cell-walls except those that are suberized, and chlor-zinc-iodide, by which the suberized and lignified walls are alike coloured yellow. In the greater number of cases the suberized wall of an isolated cell is composed of three lamellæ, the median layer consisting of suberin, and the innermost of cellulose; suberin consisting probably of a mixture of fatty substances.

* Malpighia, iii. (1890) pp. 513-39; iv. (1890) pp. 83-123.

In some trees the primary or superficial periderm persists through its whole life, in which case the phellema is continually renewed from the phellogen, in proportion as the outer layers peel off. The mistletoe is the only woody Phanerogam in which the formation of periderm is entirely suppressed.

The author then proceeds to describe the structure and development of the periderm and of the bark in a large number of species belonging to the Dicotyledones, Gymnosperms, and Monocotyledones, especially comparing the structure of this tissue in the stem and in the root. In no case was there found any fundamental difference in this respect in the two regions, and in many cases a complete agreement in every particular. Where slight differences are manifested, they are obviously related to the different environment of the root, and to its smaller increase in thickness; and these consist mainly in the greater regularity and simplicity of the phellema in the root as compared to that of the stem.

The Araucarieæ are distinguished from the other tribes of Coniferæ by the remarkable size of the cells of the periderm. All the species examined of the Abietineæ were marked by the greater or less development of phelloid tissue, with thickened and lignified walls, alternating regularly with layers of thin-walled suber. In the Taxodineæ, the Cupressineæ, and in many species of Podocarpeæ, we find an annular bark, and the phelloid tissue is wanting; the suberous cells are large, cubical, uncoloured, and with thin walls. *Gingko* (*Salisburia*), alone among Conifers, has an abundant phellema composed exclusively of large suberous elements.

Development of the Stem of Conifers.*—M. H. Douliot calls attention to the two theories on the mode of growth and structure of the summit of the stem in Conifers. Hanstein distinguishes at the summit of the stem three groups of cells, the dermatogen, the periblem, and the plerome, while the conclusions of Nägeli are diametrically opposed to this. The author then takes several examples, and carefully describes their structure. In *Picea excelsa* the development can be clearly traced, and there can be no doubt that the epiderm and the cortex have a common origin; the initial cell is in this case tetrahedral. In *Torreya nucifera* there is a certain amount of analogy with the Equisetaceæ, and some observers state they can trace three distinct histogenic regions in *Sequoia sempervirens*. This, however, is an error.

Cortical Fibrovascular Bundles.†—Prof. M. M. Hartog describes the occurrence, in *Gustavia* and *Lecythis* (Lecythideæ), of a complete system of cortical bundles external to the pericycle, anastomosing with the leaf-traces of the central cylinder at the nodes. They have often a complete circle of exogenous wood, and are all but concentric. In *Stravadium racemosum* (Barringtonieæ) there are similar bundles, but the orientation of the liber is reversed.

Vascular Bundles of Dahlia.‡—Dr. O. Kruch finds the stem of *Dahlia imperialis* to agree with that of many other species of Cichoriaceæ in the presence of medullary vascular bundles, but presents specialities,

* Journ. de Bot. (Morot), iv. (1890) pp. 206–12 (4 figs.).
† Ann. of Bot., iv. (1890) pp. 299–300.
‡ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 410–3.

which are described in detail, in the constitution of the vascular cylinder and in the presence of special formations in the cortex. Another peculiarity consists in the presence at the base of the branch of formations, consisting of phloëm only, or of both xylem and phloëm, originating from the endoderm.

Conducting Cells in Gymnosperms.*—Prof. E. Strasburger describes the nature of the cells which, in Gymnosperms, perform the function of the conducting cells in the sieve-portion of the vascular bundles of Angiosperms. In Vascular Cryptogams this function is performed by elongated parenchymatous cells containing more or less protoplasm, which either surround the sieve-tubes or are intercalated between them. In Gymnosperms also similar elements are found; there is always a relationship between the sieve-tubes and certain parenchymatous elements which surround them. In the Abietineæ this function is performed by certain rows of cells in the medullary rays; in a portion of the Cupressineæ and Taxodineæ, by certain rows in the medullary rays, and by others in the bast-parenchyme; in another portion of the Cupressineæ and Taxodineæ, and in the Taxineæ and Araucarieæ, by rows in the bast-parenchyme only. The arrangement in the Gnetaceæ and Cycadeæ resembles most nearly that in the Araucarieæ. The peculiarities of structure in the different suborders is described in detail; the parenchymatous cells which have this relation to the sieve-tubes all agree in being comparatively rich in protoplasm; in containing, when they are most active, no starch, and in the fact that they finally communicate with the sieve-tubes by pits of a peculiar kind.

Assimilating Tissue in Atriplex nummularia.†—According to Prof. G. Arcangeli, in the leaves of this shrubby species of *Atriplex*, the epiderm is alike on both sides, and the palisade-tissue is transformed into an assimilating tissue consisting of cells nearly destitute of chlorophyll, but containing abundance of water; and the sheath of the vascular bundles has undergone a similar transformation, this being apparently the chief seat of the assimilating function. A similar structure occurs also in the wings of the leaf-stalk; and it is probable that it is presented also by other species of the genus which grow in dry sunny situations.

Mucilage-cells in the Seeds of Cruciferæ.‡—M. J. D'Arbaumont states that it is well known that many families, and notably Cruciferæ, contain, in their peripheral and epidermal cells, a mucilaginous substance which has the property of considerably swelling in water. Several opinions have been put forward as to the nature and anatomical value of mucilage-cells. According to several authors, their walls remain thin, and the mucilaginous substance accumulates as a deposit in their cavity, and ends by filling it up entirely. According to others, the mucilage forms solely in the external walls of the cells, which consequently thicken considerably.

The author commences with a careful study of the seeds of *Capsella*. When the seed has arrived at maturity, the epidermal cells lose some of their water; they contract and flatten, and take that consistence which

* SB. K. Preuss. Akad. Wiss., 1890, pp. 205–16 (1 pl.).
† Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 426–30.
‡ Ann. Sci. Nat. (Bot.), xi. (1890) pp 124–84 (1 pl.).

is characteristic of vegetable mucilages, and form round the seed a colourless, continuous and apparently homogeneous pellicle. When placed in water, a large part of the internal substance of the cells is immediately reduced to mucilage, and swells considerably.

The mucilage-cells of *Sisymbrium Sophia*, *Teesdalia Iberis*, *Hutchinsia petræa*, and *Arabis Thaliana* are constructed on nearly the same plan as those in *Capsella*.

In the various species described, notwithstanding some individual variations, there is a remarkable similarity in the structure of the cell. There is always a wedge-shaped portion of amorphous cellulose, often thin at the summit, and in the remainder of the cell there is a striation, the striæ of which are in the direction of the axis of this column.

The author has embraced in his observations 90 species of the natural order Cruciferæ.

Secretory Apparatus of Papilionaceæ.*—Mr. W. Russell states that secretory cells were first pointed out in the Papilionaceæ by Sachs in *Phaseolus*; but it was Trécul who more exactly determined their precise nature. As a conclusion the author states that tannin is in the Papilionaceæ an excretory product, which is first localized in special cells analogous to laticiferous cells; these appear in the bundles before their differentiation into xylem and phloëm.

Mucilaginous Endosperm of Leguminosæ.†—Herr H. Nadelmann states that in all cases where the seeds of Leguminosæ possess an endosperm, the walls of the endosperm-cells are provided with secondary thickenings, consisting of true mucilage, not cellulose-mucilage. From an examination of the structure of this endosperm in a large number of species, he draws the following general conclusions.

The mucilage in these secondary thickenings serves in the first place as a reserve food-material; they are used up in the germination of the seed. In the cells of the cotyledons of the seeds of Leguminosæ, the secondary thickenings always consist of cellulose or amyloid, not of mucilage; they serve, however, the same purpose. The mode in which the absorption of these secondary thickenings of the endosperm-cells takes place during germination varies in different cases. Whether these thickenings occur in the endosperm-cells or in those of the cotyledons, this absorption is accompanied by the formation of transitory starch in the cotyledons. Where this mucilage is present in large quantities, other reserve-substances, except starch, are nearly or entirely absent. The mucilage may either be directly formed as such, or may be first produced as cellulose, and then transformed into true mucilage; when, in the cells of the ripe cotyledons, the thickenings consist of amyloid, they are formed directly as such.

Anatomy of Saxifragaceæ.‡—Dr. K. Leist treats in great detail of the anatomical structure of the genus *Saxifraga*, describing its variations in the different species. In the stem the course of the vascular bundles presents remarkable deviations according to the species; *S. Cotyledon*

* Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 341–4.

† Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 609–91 (3 pls.).

‡ Bot. Centralbl., xliii. (1890) pp. 100–3, 136–42, 161–71, 233–8, 281–8, 313–22, 345–53, 377–82 (6 figs.).

possesses an additional bundle-system in the pith. With regard to the leaves, it is seldom that any anatomical character can be assigned to a particular species, the histological characters of the leaf varying greatly in the same species under the influence of climate and of habitat. The arrangement and distribution of the stomates is very uniform, but they may either be elevated above the surface of the epiderm or depressed beneath it, according as the individual grows in a moist or in a dry situation.

Anatomy of Keteleeria.*—Sig. R. Pirotta has examined the anatomical structure of *Keteleeria Fortunei*, a monotypic conifer; the following being the most important results obtained. The root is characterized by the presence of a primary resiniferous axial canal, and of secondary resin-canals arranged irregularly in the secondary wood, and by the presence of mucilage-bearing idioblasts in the secondary cortex. The branches also contain resin-canals and mucilage-bearing idioblasts in the primary cortex, while these are absent from the secondary cortex and secondary wood. The leaves are of bilateral structure with heterogeneous mesophyll, and contain two lateral and marginal resin-canals and mucilage-bearing idioblasts in the mesophyll. On the under surface of the leaf the stomates form two broad zones on the sides of the mid-rib; there are none on the upper surface of the leaf.

(4) Structure of Organs.

Andrœcium of Malvaceæ.†—From an examination of the development and structure of a number of plants belonging to the natural order Malvaceæ, and especially to the tribe Malveæ, Herr J. W. C. Goethart derives the following general conclusions. The andrœcium owes its origin to the activity of intercalary meristem in close connection with the petals, and developed more strongly on their anodic side. These form the "staminalpodes," which produce the rows of stamens on their margins in basipetal succession. The rudiments of stamens, which originally stand in two vertical rows, usually split tangentially, each into two stamens with two-lobed anthers, sometimes into four. Variations occur in the number of the stamens, in the displacement of the staminalpodes, and in other points. The displacement of the staminalpodes is apparently caused by the oblique insertion of the petals. The diminution in the number of stamens in the andrœcium appears to be due either to climatic influences or to reversion.

Development of the Seminal Integuments of Angiosperms.‡—M. M. Brandza states that in plants where the ovule has two integuments, the constitution and origin of the envelopes of the seed have not been generally described. In most cases the internal integument is not consumed by the development of the embryo. It persists, and often constitutes the lignified part of the seminal envelope. Sometimes the nucellus itself contributes to the formation of the envelopes of the ripe seed. It is only in certain families that the envelope of the seed

* Atti R. Accad. Lincei (Rend.), vi. (1890) pp. 561–5.
† Bot. Ztg., xlviii. (1890) pp. 337–45, 353–63, 369–79, 385–95, 401–9 (1 pl. and 3 figs.).
‡ Comptes Rendus, cx. (1890) pp. 1223–5.

is formed by the outer part of the external integument of the ovule. In plants where there is only one integument, the envelopes of the seed are either formed from this integument only or from the integument and the nucellus. Sometimes the lignified portion of the seed takes its origin from the epiderm of the nucellus.

Extra-floral Nectaries of Sambucus.*—Dr. U. Dammer finds in *Sambucus nigra* four different kinds of extra-floral nectary. Between each pair of leaves are a pair of curved narrow structures with glandular apex, which are metamorphosed stipules. In addition to these, the lower pinnules of the primary pinnæ, and the ultimate divisions or teeth of the pinnæ, may be transformed into nectariferous bodies; and interpolated between the stipular nectaries are occasionally found other bodies of the same character, which may be of the nature of excrescences.

Cladodes of Ruscus aculeatus.†—M. W. Russell describes the development and anatomy of the cladodes of *Ruscus aculeatus*. Formerly this organ was considered as a leaf; but Turpin, in 1820, distinguished it as a leaf reduced to the rudimentary state of a flattened branch. In 1840 Martins gave it the name of *cladodum*, and recent writers, with few exceptions, have considered it as a flattened branch, and of the same nature as those found in *Xylophyllum* and *Mühlenbeckia*. Van Tieghem, however, in 1884, from the disposition and orientation of the bundles, concluded that it represented a leaf united with the axillary branch from which it proceeded. The author then describes the anatomy of a branch of *Ruscus*, and calls attention to the terminal bifurcating cladode, under which is seen the flattened branch. In conclusion, the development shows that the floral peduncle is a branch of the second generation, and the comparative anatomy of the terminal and of the lateral cladode proves that this organ is neither a leaf nor a leaf united to the axillary branch from which it proceeds, but that it is a flattened branch.

Spines and Thorns.‡—Herr H. Mittmann classifies the various forms of spiny protuberances which serve to protect plants from the attacks of animals under the following heads:—(1) Root-spines; (2) Stem-spines, which may be either metamorphosed axillary or supernumerary buds; (3) Leaf-spines, the whole leaf, stipules, or portions of the leaf; (4) Trichome-spines, either from the periblem or from the dermatogen; with transitional forms between these. Examples of each of these forms are described, including the solitary case of root-spines, the palm *Acanthorhiza aculeata*.

The special common characteristics of spiny structures are the strong development and peripheral position of the mechanical tissue, which increases in strength from the base towards the apex, and the strong thickening and lignification of its cells; a corresponding reduction of the assimilating and conducting tissues; and the peculiarity, which is especially characteristic of stem-spines, that growth continues longest at the base of the organ, the apex being the oldest portion, and that which arrives soonest at maturity.

* Oesterr. Bot. Zeitschr., xl. (1890) pp. 261–4.
† Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 193–9 (10 figs.).
‡ Abhandl. Bot. Ver. Brandenburg, xxx. (1889) pp. 32–71 (2 pls.).

Multiple Buds.*—M. W. Russell points out that multiple buds are in connection through their vascular bundles; that is, the central cylinder of one branches from that which precedes it, as the central cylinder of a branch does from that of another branch; they therefore ought to be considered as normal ramifications.

Structure of the Leaves of Aquatic Plants.†—M. C. Sauvageau describes the minute structure of the leaves in the three genera *Zostera*, *Cymodocea*, and *Posidonia*.

If a transverse section of the leaves of *Z. marina* be made at the base of an adult lamina, the epiderm will be found to consist of a continuous layer of small cells, the inner walls being thin, and the outer wall covered with a thin layer of cuticle, and they contain chlorophyll. The epiderm is never in direct contact with the lacunæ of the parenchyme, being separated from it by one or two layers of cells. The fibrovascular bundles become closer in proportion as they are distant from the median bundle, and are each supported by a layer of large cells which separate them from the neighbouring lacunæ. Between the xylem and the epiderm are three or four rows of cells. The marginal bundle on each side is near the edge, and is surrounded by a less dense tissue. The parenchyme between the bundles contains large lacunæ running the length of the lamina, and parallel to the veins, sometimes bifurcating or fusing, but without changing their disposition or their form, as seen in transverse section.

The leaf of *Z. marina* is characterized:—(1) by its completely closed sheath; (2) by the 5–9 parallel veins; (3) by the prolongation of the median vein to the apex; (4) by the absence of endoderm or of pericycle in the fibrovascular bundles; (5) by the lacunæ being disposed in a single row; (6) by the non-lignified sclerenchymatous fibres, which are subepidermal or surround the fibrovascular bundles; (7) by the absence of secretory cells. In *Z. nana* the general structure is very much the same as in *Z. marina*, but there are only three fibrovascular bundles—one median and two marginal, of which the structure is also the same. Between the bundles on each side are 3–6 lacunæ. The sheath, instead of being closed as in *Z. marina*, is open throughout its whole length, while the ligule is identical. *Z. Mülleri* replaces *Z. nana* in Australia; and, as in that species, there are three fibrovascular bundles.

The genus *Cymodocea* has been divided into three subgenera, *Phycagrostis*, *Amphibolis*, and *Phycoschœnus*. In *C. æquorea*, a Mediterranean plant, the leaves are alternate, distichous, liguled, and with long sheaths. There are nine veins connected together by anastomosing transverse branches, and this species is characterized by the presence at the extremities of secretory cells. The epiderm is alike on the two faces, and is composed of small cells with fairly thick walls. The leaf of *C. æquorea* is characterized (1) by its sheath with free edges; (2) by the lamina being indented at the edge near the summit; (3) by the 7–9 veins; (4) by the median vein not quite reaching the apex; (5) by the presence

* Comptes Rendus, cx. (1890) pp. 1277–9.

† Journ. de Bot. (Morot), iv. (1890) pp. 43–50, 68–76, 117–26, 129–35, 173–8, 181–92, 221–9, 237–45 (38 figs.). Cf. this Journal, 1889, p. 659.

of an endodermal sheath surrounding each fibrovascular bundle, and of a continuous pericycle in the median bundle; (6) by the lacunæ being arranged in three rows at the base of the lamina, and in a single row towards its apex; (7) by the presence below the epiderm of bundles of fibres which are sometimes lignified; (8) by the presence of secretory cells. Two other species of the same genus are described:—*C. rotundata*, with 10-13 veins, and *C. serrulata*, from the Red Sea and Indian Ocean, with 15–17 veins.

The genus *Posidonia* includes two species—one Mediterranean and one Australian. The leaf of *P. Caulini* is characterized (1) by a sheath with free edges, (2) by a large lamina, (3) by 13–17 parallel veins, (4) by the median vein being prolonged but not quite reaching the apex, (5) by a well-developed endodermal sheath round each fibrovascular bundle, (6) by numerous lacunæ, (7) by the structure and position of the fibres of the lamina, (8) by the numerous secretory cells, (9) by the absence of transverse perforated diaphragms. *P. australis* is easily distinguished by its leaf from *P. Caulini*.

Finally, in his conclusions, the author contrasts the three genera described in this paper. The species can be distinguished from each other by the arrangement of the parenchyme and the lacunæ, by the nature of the fibrovascular bundles, by the presence or absence of secretory cells, and by the character of the endodermal sheath when present.

Pitchers of Dischidia.*—Prof. F. Delpino discusses the function of these organs, and comes to a conclusion different from that of Treub, whose observations he conjectures were made on plants growing in unnatural conditions, and to a certain extent atrophied. Delpino finds in the pitchers a large quantity of detritus consisting of the remains of ants, hymenoptera, and other insects, a portion of which he believes to have been truly digested, and to have entered into the composition of the tissues. The principal object of this supply of nutriment appears to be to furnish material for the numerous adventitious roots of this epiphytic plant.

Resinous Leaves.†—Herr G. Volkens has examined the structure of a large number of plants with resinous leaves belonging to many different natural orders, and classifies them under the four following heads:—(1) The secreting organs are internal glands (*Hypericum resinosum* and possibly *Vernonia viscidula*); (2) a hypodermal tissue is filled with resin (*Fabiana squamata*, *Sarcocaulon rigidulum*); (3) the young leaves are covered with resin excreted by the stipules (*Larrea*, Zygophylleæ); (4) the leaves themselves are provided with secreting glands (all the remaining examples). Hanstein's "blastocolla" consists usually of a mixture of mucilage and resin, the former resulting from a decomposition of cellulose, the latter already fully formed in the "colleters." Plants with viscid or resinous leaves are almost invariably natives of arid climates, and the secretion is obviously a provision against excessive transpiration.

* Malpighia, iv. (1890) pp. 13-7 (1 pl.).
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 120-40 (1 pl.).

Glaucosity of Leaves.*—According to Prof. F. Delpino, when the formation of wax in the outermost walls of epidermal cells is sufficiently great for it to be exuded in the form of rodlets, it serves the purpose not merely of reducing transpiration and confining this function to the stomates, but has also a protective function in preventing ants and other insects from crawling over them and reaching the organs which they would otherwise injure.

Aerial Roots of Dicotyledons.†—Herr L. Keller has examined the structure of the aerial roots of seventeen species of terrestrial plants belonging to the natural orders Asclepiadeæ, Gesneraceæ, Bignoniaceæ, Begoniaceæ, Marcgraviaceæ, Vitaceæ, Urticaceæ, Piperaceæ, Opuntiaceæ, and Rosaceæ; he finds that they present no analogy to the aerial roots of Monocotyledons. They have no velamen, and the endoderm is not composed of long and short cells. In all important points of structure the aerial correspond to the underground roots of the same species; the differences consist chiefly in the presence in the cortex of sclerenchymatous cells or of crystals, or in details connected with the environment of the organ. Various special points of structure characteristic of the individual species are described in detail.

Splitting of Roots and Rhizomes.‡—Herr L. Jost discusses the phenomena connected with the splitting off of the active and living from the dead tissue, which occurs in the course of their secondary growth in thickness in some roots and rhizomes; those specially examined were *Gentiana cruciata*, *Corydalis nobilis*, *C. ochroleuca*, *Aconitum Lycoctonum*, *Salvia pratensis*, and *Sedum Aizoon*. He finds it to depend on the dying of those portions of tissue which are in direct connection with the new annual organs, the leaves and flower-stalks. The living parts may be cut off from these dead portions by a periderm composed of several layers, or may be surrounded by a single or by a few layers of cork-cell, or there may even be no suberized membrane.

Structure of Sarcodes.§—Prof. F. W. Oliver describes in detail the structure of this little-known genus from California belonging to the Monotropeæ. *S. sanguinea* is a saprophyte growing among roots of pine-trees, but without any organic attachment to them by means of haustoria; its roots are closely enveloped by a mycorhiza, which, differently from what is the case in *Monotropa*, clothes them up to the tips. It is entirely destitute of chlorophyll, but the whole of the aerial portion of the plant is coloured a brilliant crimson, due to the presence in the superficial cells of a soluble red pigment probably allied to tannin. The starch-grains which abundantly fill the parenchyme are undistinguishable, in physical and chemical properties, from those of ordinary green plants. The leaves are reduced to scaly imbricate structures, and stomates are entirely wanting. The filaments of the fungus-mycele never enter the epidermal cells. The lateral roots in *Sarcodes* have an exogenous origin, and differ in this respect from those of *Monotropa*.

* Malpighia, iv. (1890) pp. 17–20.

† 'Anat. Studien üb. d. Luftwurzeln einiger Dikotyledonen,' Heidelberg, 1889, 44 pp. and 1 pl. See Bot. Centralbl., xliii. (1890) p. 149.

‡ Bot. Ztg., xlviii. (1890) pp. 433–45, 453–62, 469–80, 485–93, 501–10 (1 pl.).

§ Ann. of Bot., iv. (1890) pp. 303–26 (5 pls.).

The inflorescence differs from that of other Monotropeæ in being of the indefinite type. The pollen-grains are loose and powdery; the pollen-tubes are provided with large plugs, which cut off the cavity of the younger from that of the older portion. The mode of development of the ovules agrees closely with that in *Monotropa*.

β. Physiology.

(1) Reproduction and Germination.

Anemophilous and Cross-fertilized Flowers.*—Prof. F. Delpino describes the mode of pollination in the following species:—*Bocconia frutescens* (Papaveraceæ) presents an example of an originally entomophilous reduced to an anemophilous normal structure. Similar phenomena are exhibited by *Dodonæa viscosa* (Sapindaceæ), an anemophilous member of a family usually entomophilous. The flowers of *Erica scoparia* are adapted for absolute and exclusive anemophily, in remarkable contrast to the nearly related *E. arborea.* In *Mercurialis perennis*, which is anemophilous and diœcious, the uppermost leaves on the female plants have a funnel-like form remarkably adapted for catching and retaining the pollen-grains. *Barnadesia rosea* (Compositæ Labiatifloræ) presents a very interesting structure for promoting cross-fertilization. In *Sauromatum guttatum* the arrangements for cross-fertilization within the spathe resemble those in other Araceæ; but the fertilizing insects in this instance are large carnivorous flies.

Parasitic Castration.†—MM. A. Magnin and A. Giard describe the actions of *Ustilago antherarum* and other parasites on *Lychnis vespertina* and different plants belonging to the Caryophyllaceæ; they may be of three kinds:—*androgenous*, which incites the production of male organs in the female host; *thelygenous*, which produces female organs in the male host; and *amphigenous*, which produces the transformation in flowers of either sex.

M. Giard ‡ calls attention to the parasitic castration of *Hypericum perforatum* by *Cecidomyia Hyperici*, and by *Erysiphe Martii.*

M. Magnin § further describes similar phenomena in *Anemone ranunculoides* attacked by *Æcidium leucospermum* (*Puccinia fusca*), resulting in more or less complete atrophy of the various floral whorls, especially of the carpels.

M. Magnin ‖ also calls attention to the androgenous castration of *Muscari comosum* by *Ustilago Vaillantii.* Normally the terminal tuft of the spike in this species consists of perfectly neuter flowers, without a trace of either stamens or pistil. When attacked by the parasite, the flowers of this terminal tuft are deformed, but produce stamens as well developed and as fertile as those of the flowers in the lower part of the inflorescence.

The parasitism of the æcidium of *Uromyces Pisi* on *Euphorbia cyparissias* produces very remarkable results. The axis is elongated and

* Malpighia, iv. (1890) pp. 24–32 (1 pl.).

† Bull. Scient. France et Belgique, 1889, pp. 151–60. See Biol. Centralbl., x. (1890) p. 20. Cf. this Journal, *ante*, p. 208.

‡ See t. c., p. 21.

§ Comptes Rendus, cx. (1890) pp. 913–5.

‖ T. c., pp. 1149–52.

thickened, the leaves are deformed and thickened, and the inflorescence is altogether aborted. Of these plants the peridium and the spermogones of the parasite develope a honey-like secretion altogether resembling that produced in the glands of the normal flowers, although, of course, it can have no function either nutritive or for attracting insects. It appears to be a means provided for carrying out a necessary physiological function of the plant.

Pollination and Dissemination of Gymnosperms.*—Prof. F. Delpino points out an interesting difference between *Ephedra* and all other genera of Gymnosperms in the structure of the ovule, connected with the mode of pollination. In all Gymnosperms the micropylar tube is filled with a fluid which exudes from its orifice in the form of a drop. In all the genera except *Ephedra* the pollen-grains have a lower specific gravity than this fluid; and in them either the ovules are inverted and the inflorescence erect (*Abies*, *Larix*, *Pinus*, *Podocarpus*), or the ovules are erect and the inflorescence pendent (*Cupressus*, *Biota*, *Thuja*, *Taxus*, *Cryptomeria*, &c.). In *Ephedra* alone the pollen-grains have a higher specific gravity than the fluid; and here the ovules and the inflorescence are both erect.

In many monœcious conifers, cross-fertilization is promoted by the arrangement of the male and female flowers; as, e. g. in *Cedrus Libanus*, where the male flowers are usually borne on the lower, the female flowers on the upper branches. The dissemination of the seeds of many conifers is provided for by their being enveloped in a coloured fleshy pulp, which is eaten by birds. The fruit of *Ephedra* bears a striking resemblance to that of *Taxus*; but the pulp is not in this instance of the nature of an aril, but results from a modification of the uppermost bracts of the inflorescence.

Pollination of the Mistletoe.†—Herr E. Loew throws considerable doubt on the statements which are commonly made, that the mistletoe is anemophilous, and that pollination takes place in the autumn, the pollen-tube penetrating to the neighbourhood of the embryo-sac, but impregnation not taking place till the following spring. The following facts point almost with certainty to the entomophilous pollination of the mistletoe. In the instances observed, the male plants are very much less common than the female. Both male and female flowers are furnished with nectaries, the nectar giving out an odour resembling that of orange-flowers, and most powerful in the male flowers. The pollen-grains are coherent when fresh, and their extine is furnished with minute spines. Both male and female flowers are fully developed in the spring, not in the autumn. The author was unable to determine what are the visiting insects, but suggests that they are bees belonging to the genus *Andrena*.

Fertilization of Bulbophyllum.‡—Mr. H. N. Ridley describes the mode of pollination in *Bulbophyllum macranthum* and some allied orchids at Singapore. The sepals exude a sweet substance resembling honey-dew, which is eagerly sought by a small dipteron. The feet of this

* Malpighia, iv. (1890) pp. 3–9. † Bot. Centralbl., xliii. (1890) pp. 129–32.
‡ Ann. of Bot., iv. (1890) pp. 327–36 (1 pl.).

insect slip from the glassy surface of the sepals, and it clutches at the small curved tongue-shaped lip which hangs between them. The base of this lip is balanced on the apex of the foot of the column; it gives way under the weight of the insect, which is thrown violently on to the column, striking the disc of the pollinia, which become fixed with great precision on the first segment of the abdomen. The insect then flies to another flower, and, going through the same process, places the pollinium on the stigma of this second flower. The author regards the whole group of Bulbophylleæ as specially adapted for fertilization by Diptera; the species of *Dendrobium*, on the other hand, by bees.

Fertilization of Physianthus albens.*—Mr. A. Harvey describes the peculiar structure of this plant, belonging to the Asclepiadeæ, and known in America as the "cruel plant." To the cap which covers the pistil are attached five pairs of stiff appendages; the moths, chiefly *Noctia gamma*, which suck the honey from the nectar-glands, get their proboscis caught between these appendages, are unable to remove them, and perish in large numbers without performing any useful service to the plant.

Mr. C. Armstrong suggests † that in its native country, Brazil, this plant is visited by larger Lepidoptera, or possibly by humming-birds, which are strong enough to break away the stiff appendages, carrying off the pollinia with them, and thus bringing about cross-fertilization.

Dissemination of Seeds.‡—Prof. F. Delpino calls attention to the fact that there are two entirely different kinds of dissemination in the vegetable kingdom, one for short, the other for longer distances. It is not uncommon for the same species to produce seeds adapted for both kinds of dissemination. This is the case with those plants which produce underground seed-vessels from cleistogamous flowers, such as *Lathyrus amphicarpus* and *Linaria Cymbalaria.* Again, in many Compositæ the seeds from the ray-flowers are adapted for dissemination to shorter, those from the disc-flowers for that to longer distances.

Germination of Zostera.§—Herr H. Jensen finds the mode of germination of the seeds in *Zostera* to be very similar to that in *Zannichellia* and *Ruppia*. The dehiscence of the pericarp takes place in water, and is brought about by the swelling of its mucilaginous innermost layer. The lower end of the hypocotyl is expanded into a peltate form, and is densely covered with root-hairs during germination. On the side facing the micropyle it bears a conical projection which is a reduced radicle, but has no trace of a root-cap.

(2) Nutrition and Growth (including Movements of Fluids).

Multiplication of Bryophyllum.‖—From experiments made on the leaves of *Bryophyllum*, planted in the soil after subjection to injuries of various kinds, Mr. B. W. Barton comes to the conclusion that the marginal buds are most nearly of the nature of axillary buds of the least preferred kind, comparable to those on branches of the second or third order of ordinary plants, and that they offer an example of an

* Proc. Canadian Inst., xxv. (1890) pp. 226–9 (8 figs.).
† T. c., pp. 230–1.
‡ Malpighia, iv. (1890) pp. 10–3.
§ Bot. Tidsskr., xvii. (1889). See Bot. Centralbl., xliii. (1890) p. 42.
‖ Johns Hopkins Univ. Circular, ix. (1890) p. 62.

axial growing on a foliar structure, and so furnish further evidence of the homology of leaf and stem.

Photographic Demonstration of the Function of Chlorophyll in the living Plant.*—M. C. Timiriazeff has demonstrated the concurrence of the absorption-spectrum of chlorophyll and its physiological function by the following experiment. A leaf still attached to a plant which had been kept in the dark for two or three days, was exposed, in a dark chamber, to a well-defined spectrum, obtained by means of a Silberman heliostat, from an achromatic lens and a direct-vision prism. The invisible image produced by the deposit of starch is developed by means of a rapid decoloration of the leaf by boiling alcohol and subsequent treatment with tincture of iodine. By this process there is produced on the pale-yellow ground of the leaf the image of the spectrum of chlorophyll as if traced by Indian ink. The spectrum which registers in the living leaf the production of starch, corresponds in all respects to the curve which represents the intensity of the decomposition of carbon dioxide obtained by the method of gazometric analysis.

Assimilation of Mineral Salts by Green Plants.†—Herr A. F. W. Schimper publishes the results of detailed observation on the part played by mineral salts in the economy of the plant. Immediately on germination the phosphates begin to leave the seed; in conjunction with organic substances their ultimate goal is the growing point and the mesophyll of the leaves. The mineral acids pass through the long-celled parenchyme of the stem and veins of the leaf containing but little chlorophyll, through which sugar and the amides also pass. Halophytes, and woody plants related to them but not themselves halophytes, have a great tendency to store up chlorides, especially in the leaves.

Inorganic salts are never found in the primary meristem, the sieve-portions of the vascular bundles, the laticiferous tubes, the reservoirs for secretions, the pollen-grains, or the ovules; in the mesophyll of the leaf and the aquiferous tissue they usually occur only in small quantities, the mineral bases having been assimilated, i. e. having entered into organic combinations. The potassium passes out of the seeds in the form of potassium phosphate; the activity of the meristem is connected with the formation of nuclein, nuclein being a compound of phosphoric acid. The leaves of the vine, and probably also of other plants, contain, in addition to calcium oxalate, considerable quantities of calcium tartrate and malate.

The most important processes in metastasis, the synthesis of the carbohydrates, albuminoids, and nuclein, and the formation of protoplasmic substances, can take place without the presence of calcium, but require considerable quantities of potassium and magnesium. Lime compounds are not necessary constituents of protoplasm, nor are they necessary for the formation of new organs, nor in the process of assimilation; the indispensability of lime for the life of the plant depends on the part which it takes in processes which take place in the growing region outside the primary meristem, but not connected with assimilation.

* Comptes Rendus, cx. (1890) pp. 1346–7. † Flora, lxxiii. (1890) pp. 207–61.

Descending Transpiration-current.*—Prof. J. Wiesner finds that if *Capsella bursa-pastoris*, *Bellis perennis*, or *Sempervivum tectorum* is grown in air completely saturated with moisture, the habit of the plant is altered by the greatly increased development of the internodes of the stem. *Taraxacum officinale*, on the other hand, appears to undergo no change under similar conditions.

Ascent of Coloured Liquids in Living Plants.†—Herr F. Goppelsroeder has investigated the phenomena connected with different coloured fluids in a number of different species of plant. When very dilute he states that a large number of such pigments may pass into the plant without apparent injury. The rapidity and extent of this circulation varies with the species of plant and with the pigment employed, some pigments rising to the very summit of the plant, while others again are not absorbed at all.

Prof. G. L. Goodale ‡ contests the statement of Goppelsroeder that coloured fluids can be absorbed in this way without any disturbance to the plant itself. Plants with injured roots can live and grow slowly for a considerable time.

(3) Irritability.

Conduction of Irritation in the Sensitive Plant.§—From a series of experiments on *Mimosa pudica*, Dr. G. Haberlandt shows the untenability of the conclusion drawn by previous observers that the irritability of the leaves of the sensitive plant is conducted mainly through the xylem portion of the vascular bundles. He demonstrates, on the contrary, that the stimulus normally travels inside the zone of collenchyme or bast-fibres, but outside the xylem of the bundles, and therefore through their phloëm portion. When a stem is cut through, drops exude from the cut surface, and these can be shown to arise, not from the xylem, but from special cells in the phloëm. This special conducting-tissue is described by the author for the first time. It consists of rows of cells, somewhat larger than the ordinary phloëm-cells, in the transverse wall of each of which is a single large shallow pit, traversed by very delicate protoplasmic filaments. The contents of these cells is a crystallizable substance, probably a glucoside; they replace the tannin-sacs of other Leguminosæ. These special cells form a part of the phloëm, from the pulvinus at the base of the leaf to the larger bundles in the leaflets. Dr. Haberlandt believes that the protoplasmic filaments which penetrate the pits in the walls of these cells, play but a small part in the transmission of the irritation; it is conveyed in a purely mechanical manner from the pulvinus, as a wave or impulse passing along the glucoside-containing cells.

Sleep of Leaves.‖—M. Leclerc du Sablon states that it is well known that the leaves of certain plants, under the influence of external conditions, can take up different positions. For example, in *Oxalis*

* Verhandl. K.K. Zool.-Bot. Gesell. Wien, xl. (1890) SB., p. 30.
† 'Ueb. Capillar-analyse u. ihre verschiedenen Anwendungen,' Wien, 65 pp. See Bot. Ztg., xlviii. (1890) p. 345 ‡ Amer. Journ. of Sci., xl. (1890) p. 173.
§ 'Das reizleitende Gewebe d. Sinnpflanze.' Leipzig, 1890, 87 pp. and 3 pls. See 'Nature,' xlii. (1890) p. 561.
‖ Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 337–40.

stricta the leaf, composed of three leaflets, is horizontal during the day, but at the commencement of night each of the leaflets turns on its point of insertion. These movements, however, can be brought about in *O. stricta* and various other plants, by three different causes:—(1) by darkness; (2) by strong sunlight; (3) by contact with a foreign body. Nocturnal sleep manifests itself by the same movements as diurnal sleep, but is due to a different cause, viz. to an augmentation of the quantity of water in the pulvinus at the base of the leaflet. In the evening, when transpiration ceases, water accumulates at this point.

(4) Chemical Changes (including Respiration and Fermentation).

Action of Diastase on Starch.*—From an extended series of observations on a great variety of starch-grains—seeds of cereals, scales of the hyacinth and other bulbs, Leguminosæ, &c.—Herr G. Krabbe is able to disprove finally the theory that the grains consist of two different substances, granulose and farinose. He shows also that diastase does not penetrate between the micellæ of the starch-grain, but that the destruction of this substance by the diastase takes place in very much the same way as the solution of a crystal by the surrounding medium.

During germination (in the endosperm of wheat) a number of canals are formed on each side of the discharged starch-grain. These canals gradually extend to the interior of the grain, and have a somewhat spiral appearance (really annular) owing to the varying intensity of the action of the ferment on the different layers of starch, which vary in density. The sharply defined walls of these canals show that they cannot have been formed by an intermicellar action of the diastase on the substance of the starch, but that the molecules of starch are dissolved as such in these regions in centripetal succession. The transformation of starch into sugar is a secondary process not connected directly with the solution of the grain. The canals finally branch and anastomose, and cause the eventual complete breaking-up of the grain; these fragments then finally disappear by solution.

In large excentric starch-grains (potato, *Lilium candidum*, *Orobanche*, *Lathræa*, &c.) the dissolution of the grain takes place in a somewhat different way; it is effected very slowly and nearly uniformly, centripetally, but may be accompanied by local formation of pits or crevices. The smaller grains of the potato are, however, destroyed centrifugally by the formation of canals, and frequently of a hollow in the interior.

The author finds diastase present in the living cells of almost all parts of plants. The dissolution of the starch-grains does not appear to be brought about by microbes or other protoplasmic structures, since these cannot be detected in the canals by the Microscope or by microchemical reagents, and diastase is not immediately killed, as protoplasm is, by alcohol, but retains for a long time, when immersed in it, its fermentative power. Experimental observations on the action of bacteria on starch lead also to the same result.

The cause of the inability of diastase to penetrate between the

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 520–608 (3 pls.).

micellæ of a starch-grain is apparently the large size of its micellæ; it can, however, under sufficient pressure, permeate the cell-wall. The ferment belongs to the class of colloids. As regards its transmission from one part of the plant to another, this cannot take place in the form in which it converts starch into sugar; in order to be transported it must undergo some chemical change, and be again restored to the fermentative form at the spot where it resumes its activity. But it is not certain that it ever is transported from one part of the plant to another.

Gum-ferment.*—From an examination of the processes which take place in the living plant, with the assistance of staining reagents, Herr F. Reinitzer contests the view that the formation of gum and mucilage is due to the action of a definite ferment.

γ. General.

Alternation of Generations.†—Prof. F. O. Bower points out that under this term many writers include phenomena of two different kinds, which he proposes to call *antithetic* and *homologous* alternation of generations. In antithetic alternation we have two phylogenetically distinct generations, i. e. a new stage (the sporophyte) has been interpolated between pre-existing generations (the gametophytes or oophytes); this has probably arisen independently in several distinct phyla, and the results are not perfectly comparable with one another. It occurs in the Archegoniatæ, the green Confervoideæ, &c., the Florideæ, and the Ascomycetous Fungi. In homologous alternation we have two or more phylogenetically similar generations, but differing in the presence or absence of sexual organs. It is found in the Thallophytes, e. g. *Botrydium*, and might be described as a mere differentiation, often a very slight one, of successive gametophytes. The axis and leaf of the gametophyte in the Muscineæ are not the true homologues by descent of the axis and leaf of the sporophyte in Vascular Cryptogams, although performing the same physiological function; and the author proposes restricting the terms caulome and phyllome to the latter, and terming the former "caulidium" and "phyllidium."

The late Mr. J. R. Vaizey‡ expressed views on the whole similar to those of Prof. Bower. He regarded *Chara* as being, in all probability, connected with the Florideæ; and the morphological position of its embryo as that of an embryonic stage in the development of the oophyte, corresponding to a certain extent with the protoneme of true Mosses.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Apical Growth in Marsilea and Equisetum.§—Mr. W. M. Andrews finds the phenomena of the apical growth in roots of *Marsilea quadrifolia* and *Equisetum arvense* somewhat different from those described by de Bary and Goebel.

* Zeitschr. f. Physiol. Chemie, xiv. pp. 453–70. See Bot. Centralbl., xliii. (1890) p. 117.
† Ann. of Bot., iv. (1890) pp. 347–70.
‡ T. c., pp. 371–8.
§ Bot. Gazette, xv. (1890) pp. 174–7 (2 figs.).

In *M. quadrifolia* he states that the transition from the large initial cells into the long narrow cells of the plerome-cylinder is very gradual; from the time when the initial cells are cut off, the three tissues, dermatogen, periblem, and plerome, are distinctly differentiated. The root-cap is formed from segments cut off from the base of the pyramidal apical cell.

In *Equisetum arvense* there is no hypodermal layer as in *Marsilea*; the endoderm divides into two layers at about the fifth or sixth segment, and these two layers are not further divided by tangential walls. The description of the mode of formation and division of the root-cap differs somewhat from that of previous writers.

Fossil Plants of the Coal-measures.*—In his latest contributions to this subject, Prof. W. C. Williamson, after describing certain fossils from the Coal-measures belonging to the genera *Rachiopteris*, *Rhizonium*, and *Lepidodendron*, states his view that in the primeval Vascular Cryptogams we find important histological and physiological phenomena to which no exact parallels are to be found amongst living plants. The development of the medullary area and the coincident annular expansion of the vasculo-medullary cylinder, so characteristic of all the Carboniferous Lepidodendroid plants, he attributes rather to schizogenetic than to lysogenetic action.

Muscineæ.

Braithwaite's British Moss-Flora.—Part XIII. of this publication is devoted to the Splachnaceæ, comprising the genera *Splachnum* (3 species), *Tetraplodon* (2 species), and *Tayloria* (2 species); the monotypic *Œdipodium Griffithii*, which represents the family Œdipodiaceæ; the Funariaceæ, comprising *Discelium* (1 species), *Amblyodon* (1 species), *Nanomitrium* (1 species), *Physcomitrella* (1 species), *Physcomitrium* (2 species), and *Funaria* (6 species); and three monotypic genera of Bryaceæ, viz. *Oreas*, *Stableria*, and *Leptobryum*. It is illustrated by six beautiful plates.

Characeæ.

Antherozoids of Characeæ.†—M. W. Bijelajew has investigated the structure and development of the antherozoids in *Chara* and *Nitella*, and his conclusions differ in some points from those of Guignard.‡ Immediately after the nucleus of the mother cell has attached itself to the wall, the anterior end of the antherozoid manifests itself as a filament springing from the nucleus; from its attached end arise the two cilia. At the opposite end of the nucleus there is at the same time attached to it a somewhat stronger filiform structure, the posterior end of the antherozoid. The nucleus then also itself elongates, and becomes the middle part of the antherozoid. The cilia spring from the point of junction of the anterior end and middle portion of the antherozoid.

* Phil. Trans. Roy. Soc., clxxx. (1890) pp. 155–68, 195–214 (8 pls.).

† SB. Warschauer Naturf. Gesell., Sept. 27, 1889. See Biol. Centralbl., x. (1890) p. 220.

‡ Cf. this Journal, 1889, p. 417.

Algæ.

Anamorphic State of the Lower Algæ.*—Prof. A. Borzì has investigated the life-history of the green algæ comprised in the family Pleurococcaceæ † of Dangeard and Klebs (*Pleurococcus*, *Raphidium*, *Scenedesmus*, *Dactylococcus*, *Stichococcus*, &c.), and has come to the conclusion that they constitute a stage of development of algæ belonging to other families which he terms "anamorphic."

If the zoospores of *Ulothrix flaccida* are observed at the moment of escape, it is seen that some are endowed with an irregular vortical motion different from the others. These are pairs of zoospores which have coalesced at the extremity opposite to the beak, forming a fusiform body, straight, or more or less curved, or with the form of a V, with a cilium at each extremity. These bodies move rapidly through the water, and ultimately multiply by longitudinal oblique bipartition into fusiform or semilunar cells, having all the characters of *Raphidium;* when still united into colonies they constitute the genus *Actinastrum* Lagh. Similar raphidio-forms were observed of *Protoderma*, *Stigeoclonium*, *Dermonema*, *Chloroclonium*, and *Prasiola*.

A stichococcoid form can be induced in *Ulothrix flaccida* by growing the filaments under conditions of imperfect aeration; the cells lose their close connection with one another and become partially separated, with exceedingly thin walls. Whenever filaments in this condition grow on a substratum of a fungoid nature, a symbiosis or commensalism between the fungus and the alga seems to occur. This bacillar form of *Ulothrix* constitutes the genus *Arthrogonium* A. Br.

Bulbotrichia.‡—M. P. Hariot agrees with Bornet, de Toni, and de Wildeman, in abolishing this reputed genus of Algæ. Two distinct organisms have been included under this name; one is a lichen in the structure of which partake gonids belonging to different groups of algæ, and not merely to *Protococcus;* the other is an autonomous plant belonging to the genus *Nylandera* (Trentepohliaceæ).

New Algæ and Schizophyceæ.§—Prof. A. Hansgirg describes, under the name *Glœotænium*, a new genus of fresh-water Algæ, which he proposes as a member of a new family, Pseudodesmidiaceæ, intermediate between the Desmidiaceæ and the Palmellaceæ. It is distinguished from Palmellaceæ either by the peculiar development of the gelatinous envelope, or by the formation of zygotes; from the Desmidiaceæ by the structure of the cell-membrane, which does not consist of two distinct similar pieces, and by the cell contents being arranged cylindrically instead of bilaterally and symmetrically. The family will include the genera *Spirotænia*, *Cylindrocystis*, and *Mesotænium*, to which Hansgirg adds *Glœotænium*, although no sexual reproduction has yet been detected in it.

The following new species, from Bohemia, Carniola, Istria, and Dalmatia, are also described:—*Chantransia incrustans*, forming a dark olive-green incrustation on stones; *Endoclonium* (?) *marinum*, on mussel-shells and stone; *E.* (?) *rivulare*, on stones and wood; *Hormospora subtilis; Oocystis pusilla*, in springs on limestone and marble; *Glœotænium*

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 403-9.
† Cf. this Journal, 1889, p. 96.
‡ Notarisia, v. (1890) pp. 993-6.
§ SB. K. Böhm. Gesell., 1890, pp. 1-20, 29-33 (2 pls.).

Loitlesbergerianum, forming four-celled families, distinguished by a remarkable thick almost black median band; *Trochiscia psammophila; Dactylococcus sabulosus; Leptochæte marina*, the only known marine species of the genus; *Microcoleus polythrix; M. hospita; M cataractarum; Oscillaria rupicola; Lyngbya investiens; L. longearticulata; Spirulina adriatica; Aphanocapsa concharum*, on shells of *Patella; A. fonticola; Chroococcus fuscoviolaceus.*

The author proposes the following new classification of the Confervoideæ:—A. Vegetative cells multinucleated, Sphæropleaceæ, Confervaceæ (Anadyomenaceæ, Cladophoraceæ, Pithophoraceæ, and Conferveæ), Gomontiaceæ, Botrydiaceæ, and Sciadiaceæ; B. Vegetative cells uninucleated, Cylindrocapsaceæ, Œdogoniaceæ, Coleochætaceæ, Trentepohliaceæ, Ulotrichaceæ (Ulvaceæ, Blastosporeæ or Prasiolaceæ, Ulotricheæ, Chætophoraceæ, and Entocladiaceæ).

Fungi.

Enzyme produced by Parasitic Fungi.*—Mr. A. L. Kean confirms, in the cases of *Rhizopus nigricans, Phytophthora infestans*, and some other species, the statement of de Bary and Marshall Ward that so-called parasitic fungi produce an enzyme which destroys the tissue of the host and prepares the way for the growth of the fungus. It can be obtained by crushing the diseased tissue in a mortar and filtering, and can then be precipitated by alcohol; it is again soluble in water. In demonstrating the destructive effects of this enzyme on vegetable tissues, precautions were taken to guard against the presence of bacteria.

Employment of Parasitic Fungi against the Attacks of Noxious Insects.†—M. A. Giard points to the utilization of the Entomophthoreæ against the attacks of noxious insects. There are, however, one or two difficulties in the way; the chief being that the conidial spores of the Entomophthoreæ, by which propagation takes place most easily, only preserve their power of germinating for a very short space of time. Other groups which ought to be experimented with are the entomorphic Schizomycetes, the Isarieæ, and the Psorospermieæ.

Chytridiaceæ parasitic on Algæ.‡—M. E. de Wildeman describes twenty-one species of Chytridiaceæ found in Belgium, all of them parasitic on different species of freshwater Algæ, viz.:—*Rhizidium Schenckii* on various algæ, *R. bulligerum* and *R. Cienkowskianum* on *Spirogyra crassa*, *R. acuforme* on *Chlamydomonas*, *R. apiculatum* on *Glœococcus* sp., *R. Euglenæ* on *Euglena viridis*, *R. fusus* on a diatom, *R. sphærocarpum* on *Mougeotia genuflexa*, *R. lagenaria* on *Spirogyra* sp., *Chytridium transversum* on *Chlamydomonas pulvisculus*, *C. subangulosum* on *Oscillaria* sp., *C. mammillatum* on *Conferva bombycina* and *Stigeoclonium* sp., *C. lagenula* on *Ophiocytium cochleare*, *C. rostellatum* sp. n. on *Spirogyra crassa*, *C. globosum* on *Melosira varians*, *Phlyctidium irregulare* sp. n on a diatom, *Olpidiopsis Sorokinei* sp. n. on *Conferva bombycina*, *Olpidiopsis Schenckiana* on *Mougeotia* and *Spirogyra*, *Septocarpus corynephorus* on a diatom, *Ectrogella Bacillariacearum* on *Gomphonema* sp., and *Synedra* sp., *Polyphagus Euglenæ* on *Euglena viridis*.

* Bot. Gazette, xv. (1890) pp. 171–4. † Rev. Mycol., xii. (1890) pp. 71–3.
‡ Ann. Soc. Belge Microscop., xiv. (1890) pp. 3–28 (7 figs.).

Two new genera of Chytridiaceæ.*—Professor G. v. Lagerheim describes two new genera of Chytridiaceæ, which appear to demonstrate the near affinity of this family with the Ancylisteæ and Saprolegniaceæ.

Harpochytrium Hyalothecæ was found parasitic on *Hyalotheca dissiliens*, not merely on the gelatinous sheath, but piercing the filament itself, which it kills. The ripe zoosporange is curved into the form of a sickle; when the zoospores escape, a new cell is formed within the base of the sporange, which developes into a new zoosporange by a kind of prolification, a phenomenon hitherto known only in *Pythium* and *Saprolegnia*.

Achlyella Flahaultii was grown on pollen of *Typha*. The contents of the flask-shaped sporange, which is attached externally to the pollen-grain, divide, as in *Achlya*, *Aphanomyces*, and *Achlyogeton*, into several portions, which escape as naked masses of protoplasm through an apical opening, before which they lie in heaps. Each of these masses finally invests itself with a thin membrane, through a small opening in which the protoplasm escapes as a ciliated zoospore.

Ustilago Carbo.†—According to Herr E. Rostrup, no less than five distinct species are included under this name, comprising the parasitic fungi which cause "smut" in corn, viz.:—*Ustilago Hordei* on barley; *U. Jensenii* sp. n. on *Hordeum distichon*; *U. Avenæ* on rye, *U. perennans* sp. n. on *Avena elatior*, the mycele being perennial in the rhizome; and *U. Tritici* on wheat.

Lophiostomaceæ.‡—Sig. A. N. Berlese discusses the systematic position and the classification of this family of Pyrenomycetes, distinguished by the presence of a compressed ostiole which is furrowed longitudinally by a more or less open fissure, frequently very narrow, formed of two small lips. In the form of the ostiole some species approach the Sphæriaceæ, others the Hysteriaceæ. The genera described by Saccardo are characterized by the author as follows:—

Sporidia continua fusca	*Lophiella.*
Sporidia bilocularia fusca	*Schizostoma.*
hyalina	*Lophiosphæra.*
Sporidia transverse pluriseptata hyalina	
Perithecia pilosa	*Lophiotricha.*
Perithecia calva	*Lophiotrema.*
Sporidia transverse pluriseptata fusca ..	*Lophiostoma.*
Sporidia muriformia fusca	*Lophidium.*
hyalina	*Lophidiopsis.*
Sporidia filiformia	*Lophionema.*

The 213 species enumerated by Saccardo must, he thinks, be greatly reduced in number. The family exhibits an alliance with the Hysteriaceæ, the connecting link between the Pyrenomycetes and the Discomycetes, rather than with the Sphæriaceæ, especially in the branched paraphyses.

* Hedwigia, xxix. (1890) pp. 142–5 (1 pl.).
† Bull. Acad. Roy. Copenhagen, 1890, No. 1, 16 pp. and 1 pl.
‡ Malpighia, iv. (1890) pp. 40–55.

Structure and Development of Collemaceæ.*—Mr. W. C. Sturgis's observations agree with those of Stahl, that in the Collemaceæ the fructification always arises from an impregnated carpogone, and the paraphyses from vegetative hyphæ. The only exception is in the case of *Hydrothyria venosa*, which the author removes from the Collemaceæ, and places in the neighbourhood of *Peltigera* and *Pannaria*. He differs, however, from Stahl and Lindau in his account of the development of the heteromerous lichens. In those examined, *Sticta*, *Nephroma*, *Peltigera*, *Pannaria*, and *Hippia*, he finds no carpogone, the fructification having a purely vegetative origin, the asci and paraphyses originating from the same hyphal system.

Koji, an Inverting Ferment obtained from Rice.†—In the preparation of wine, spirit, and other fermented liquids, the Chinese and Japanese use koji, a peculiar substance which has the property of decomposing starches; it is obtained from rice which has been steamed and freed from husk, by inoculating with the spores of a fungus not yet properly classified, and developes a luxuriant and snow-white mycele.

According to Ahlborg the fungus belongs to the genus *Eurotium*, and its specific name is *E. Oryzæ*. It has long been known in Japan that koji changes starch into fermentable sugar. According to Atkinson koji contains a ferment which is soluble in water, inverts cane-sugar, and transforms maltose, dextrin, and starch into dextrose.

According to the researches of the authors (Kellner, Mori, and Nagaoko). koji contains a powerful inverting ferment which changes cane-sugar into dextrose and levulose, maltose into dextrose, and starch into dextrin, maltose, and dextrose, while milk-sugar and, apparently, also inulin are not altered by it.

Of the known inverting ferments, koji therefore seems to possess the greatest power.

The authors propose for it the provisional name of "invertase," but are uncertain whether it is a simple body or consists of several ferments, and they further express the opinion that invertase is possibly produced, not only by *Eurotium Oryzæ* Ahlborg, but that other fungi of the same or allied genera are capable of producing the ferment.

Koji is made in the following manner:—The rice, which has been properly bleached and husked, is steamed for about twelve hours, until it is thoroughly softened. It is then spread out on straw mats to cool, and when its temperature has fallen to 28–35°, a small quantity is mixed with the yellowish-brown spores of the fungus, and this mass in its turn mixed with the rest of the material. If at hand koji itself may be used instead of the spores. The mats are then placed in the front part of a sort of cellar, which is either dug out of the ground, or if above, is surrounded by thick walls.

In 18–20 hours the mycele has already developed, and the temperature is at the same time considerably increased. The grains are next worked up with the hands, and then, having been spread on small

* Proc. Amer. Acad. Arts and Sciences, xxv. (1890) pp. 15–52 (8 pls.). See Bot. Ztg., xlviii. (1890) p. 530.

† Zeitschr. f. Physiol. Chemie, 1889, pp. 297–317. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 672–4.

trays, are deposited in the warmest parts of the cellar. In 10–12 hours more the grains are again worked up, and are then cooled and moistened with a little water; in about ten hours this is repeated, and after 14–16 hours the koji is ready. The whole process lasts about two and a half days.

Torula spongicola.*—Sig. U. Martelli describes a parasitic fungus which causes dark spots on the surface of a toilet-sponge, or sometimes colours the whole surface. The discoloration is caused by the mycele, the spores apparently retaining their vitality for a very long period.

Parasitism of Tichothecium.†—Herr C. Mäule has followed out the development of *Tichothecium microcarpon*, which appears in the form of black dots on lichens belonging to the genus *Callopisma*. From the mode of their occurrence he concludes that the spores cannot have found their way into the mature lichen from the outside, but must have reached its fructification at the time of its first formation. He further observed the remarkable fact that the spores of *Tichothecium* never germinate in the thallus of the lichen, nor in the neighbourhood of the gonids, but only in the fructification, where alone they appear to find the requisite supply of food-materials, apparently in the transformation of the cellulose of the vegetative hyphæ into the "fungus-cellulose" of the asci.

Pucciniæ parasitic on Veronica.‡—Dr. P. Magnus describes four species of *Puccinia* parasitic on various species of *Veronica* in Europe, viz. *P. Veronicæ* Schröt., *P. Veronicarum* DC., *P. Albulensis* sp. n., and *P. Veronicæ Anagallidis* Oudem. All these species form only teleutospores and sporids on their promycele; and all, except doubtfully the last, belong to the section *Leptopuccinia*, in which the teleutospores germinate as soon as they are ripe; some of them have also deciduous thick-walled teleutospores which do not germinate immediately on maturity, as occurs also with other species of *Leptopuccinia*.

Æcidioform of Uredineæ on two different hosts.§—Herr P. Dietel finds, from culture experiments, that the æcidia parasitic on *Hippuris vulgaris* and on *Sium latifolium*, known as *Æcidium Hippuridis* and *Æ. Sii latifolii* respectively, are both genetically connected with *Uromyces lineolatus*, parasitic on *Scirpus maritimus*.

Fungus-parasites of the Onion.‖—Mr. R. Thaxter gives further description of the life-history of *Urocystis Cepulæ*, and of the injury inflicted by it on the onion-crop in the United States. Infection appears to take place entirely during early stages of the host, and from spores contained in the soil. The spores certainly retain their vitality for five, and possibly even for twenty years.

Peronospora Schleideni is also very destructive to the onion-crop in Connecticut, and is frequently followed by *Macrosporium Sarcinula*.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 463–5.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 113–7 (1 pl.).
‡ T. c., pp. 167–74 (1 pl.).
§ Hedwigia, xxix. (1890) pp. 149–52.
‖ Ann. Rep. Connecticut Agric. Exp. Stat. for 1889, pp. 127–77 (3 pls.). See Bot. Centralbl., xliii. (1890) p. 30.

Lysurus.*—M. N. Patouillard points out that in this genus of Phalloideæ two distinct types have been included, one having the basids on the outer, the other on the inner surface of the lobes of the receptacle. He classifies the genera of Phalloideæ as follows:—I. PHALLEÆ, glebe covering the outer surface of the receptacle (Mitreæ, Capitreæ, Lysureæ, Kalckbrennereæ); II. CLATHREÆ, glebe covering the inner surface of the receptacle (Conjugeæ, Anthureæ).

Rabenhorst's Cryptogamic Flora of Germany (Fungi.)—The last three parts (31–33) of the section of this work devoted to Fungi, now edited by Dr. H. Rehm, are still occupied by the Pezizaceæ. The suborder Dermateaceæ (including the Cenangieæ, Dermateæ, Patellariaceæ, and Bulgariaceæ) occupies their greater portion, the section Caliciеæ being just commenced. A number of new species and several new genera are described.

Protophyta.

α. Schizophyceæ.

Pure Culture of Green Protophyta.†—Herr M. W. Beyerinck has succeeded, though with great difficulty, in raising pure cultures of *Chlorococcum protogenitum* and *Raphidium naviculare*, free from the countless bacteria which infest stagnant water.

The *Raphidium* was found to throw off an enzyme which slowly deliquesces gelatin.

The *Chlorococcum* presents characters identical with the Zoochlorellæ of the lower freshwater animal organisms, such as *Hydra*, *Paramecium*, &c. The modes of increase are precisely the same in both, and are twofold, viz.:—(1) Occasionally, in large cells under favourable conditions, division takes place by constriction, as in chlorophyll-grains. (2) After the lens-shaped chlorophyll-bodies have divided into 2, 4, or 8 sections, the membrane of the mother-cell is thrown off. The eight (or fewer) free protoplasts round themselves off, containing each a lens-shaped chlorophyll-body, and grow to the normal size. In other morphological characters, such as the presence of a nucleus, and the form of the amylaceous body in the chromatophores, *Chlorococcum* and the Zoochlorellæ agree altogether.

The author describes in detail processes by which he was able to demonstrate that the living green cells can decompose carbon dioxide in a medium containing no oxygen, and can be supplied with free oxygen by means of a Schizomycete, *Mycoderma Sphæromyces*.

Coscinodiscus.‡—Mr. J. Rattray continues his monographs of genera of diatoms with a revision of the genus *Coscinodiscus* and of some allied genera. Of *Coscinodiscus* he describes about 290 species, some of them new. The other genera included in the monograph are:—*Actinogonium* (2 species), *Brightwellia* (6 species), *Stelladiscus* gen. n. (1 species),

* Journ. de Bot. (Morot), iv. (1890) pp. 253–8 (5 figs.).

† Aanteek. Utrechtsch Genoots. Kunst. en Wetensch., 1889, pp. 35–52. See Bot. Centralbl., xliii. (1890) p. 142.

‡ Proc. Roy. Soc. Edinb., xvi. (1888–9) 1890, pp. 449–692 (3 pls.). Cf. this Journal, 1888, p. 861.

Asterolampra (35 species), *Asteromphalus* (24 species), *Liradiscus* (7 species), *Porodiscus* (9 species), *Thaumatonema* (2 species), and *Peponia* (1 species). *Stelladiscus* is separated from *Asterolampra* by the different appearance of the compartments and rays.

β. Schizomycetes.

New Schizomycetes.*—Prof. A. Hansgirg describes two new genera of Schizomycetes :—*Mycacanthococcus*, in which the cells, in the encysted condition, have their membrane covered with spiny or watery protuberances, comparable to *Glochiococcus* among Schizophyceæ. *Microtetraedron* occurs in roundish quadrilateral isolated cells, with a long, colourless, conical spine at each corner; it resembles *Tetraedron* or *Polyedrum* among Schizophyceæ.

The following new species are also described :—*Crenothrix marina*, *Leptothrix subtilissima*, *Bacillus fenestralis*, and *Leucocystis fenestralis*, on the windows of greenhouses ; and the following on damp walls in wine-cellars,—*Cladothrix cellaris*, *Bacillus Pfefferi*, *Sarcina cellaris*, *Ascococcus cellaris*, *Myothece urothece*, *Leucocystis schizocystis*, *L. urococcus*, *Mycacanthococcus cellaris*, *Mycotetraedron cellare*, and *Micrococcus oinophilus*.

Bacillus Pfefferi occurs as motionless rods imbedded in a greyish-yellow mucilage on the damp walls of an underground wine-cellar. When exposed to light and a sufficiently high temperature, it passes into a motile condition, but without any formation of cilia; in this respect it differs from *Spirochæte*. The author regards the movements of this organism, of *B. megaterium*, *B. Zopfii*, *Beggiatoa*, and *Spirochæte*, as of a similar character, and to be dependent on similar causes, to those of the Oscillariaceæ.

Hansgirg regards *Mycacanthococcus* and *Mycotetraedron* as true Schizomycetes, belonging, along with *Crenothrix*, *Leuconostoc*, and other genera, to the arthrosporous section, which he treats as an intermediate group between the Algæ (Schizophyceæ) and the endosporous Schizomycetes, and proposes for them the term Mycophyceæ, in contrast to the Eubacteriaceæ. It will include the Crenotrichaceæ, Leptotrichaceæ, Myconostocaceæ, and Mycococcaceæ. Between these and the Mycophyceæ or Cyanophyceæ there are various transitional forms, while none are at present known between the latter and the chlorophyll-green algæ or Chlorophyllophyceæ.

New Bacillar Disease of Plants.†—MM. E. Prillieux and G. Delacroix find the stem of potatoes from various parts of France attacked by a gangrene, which appears to be caused by the presence of enormous quantities of a bacillus in the diseased cells. A similar malady also attacks the *Pelargoniums*, and the disease can be infected from one of these plants to the other. The authors propose for the microbe the specific name *Bacillus caulivorus;* it measures about 1·5 μ in length, and from 0·33 to 0·5 μ in diameter. It is decidedly smaller than the *B. Hyacinthi*, which produces a similar disease in the hyacinth, but may be identical with Comes' *Bacterium gummis*.

* SB. K. Böhm. Gesell. Wiss., 1890, pp. 20–31 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 208–10.

Micro-organisms of Fresh Vegetables.*—Although the researches of Pasteur, Fernbach, Buchner, and others have shown that under normal circumstances no bacteria are present within vegetable tissues, Dr. Fazio has examined fresh vegetables, such as fennel, celery, lettuce, and endive, in order to ascertain if micro-organisms existed in the interspaces of the buds and leaves. With this object the plants taken from the garden were first externally purified, then superficially charred, and then pieces removed under proper antiseptic precautions with a kind of cork-borer. The pieces were placed in test-tubes containing bouillon, and left for 24 to 48 hours. If obvious clouding occurred, then further examination was made with gelatin plates. In this way four kinds of saprophytic bacteria were constantly demonstrated.

Resistance of Spores to High Temperatures.†—Dr. Lewith, from a series of experiments, finds that the increased resistance of spores to dry heat is due to the fact that, during their formation, an inspissation of the protoplasm occurs from loss of water. From experiments with egg-albumen, he estimates that the most resistant spores contain about 10 per cent. of water; but, stated from a practical point of view, that is, for disinfection purposes, the proportion nearly amounts to this, the less the amount of water in the spores and the more impenetrable the spore-membrane, the greater is the resistance of the spores. Hence, for complete disinfection by heat, moisture is of importance. This, too, holds good for disinfection with chemical substances, such as sulphuric acid, chlorine, bromine, and sublimate, for they can only properly act in the presence of water.

Influence of Carbonic Acid and other Gases on the Development of Micro-organisms.‡—Mr. P. F. Frankland exposed plate-cultivations of *Bacillus pyocyaneus*, cholera spirilla, and Finkler's spirilla in a simple apparatus to the action of carbonic acid, carbonic oxide, sulphuretted hydrogen, sulphurous acid, hydrogen, nitrous and nitric oxide. It was found that three kinds of bacteria were quickly killed by NO, H_2S, and SO_2, that CO and N_2O acted less vigorously than CO_2, and that they were least affected by H. With regard to the experiments with carbonic dioxide, it was found that *B. pyocyaneus* recovered perfectly when exposed to the air, but that the other bacteria did not—a result contrary to that obtained by Fraenkel.

Resistance of living Bacteria and Yeast-cells to Pigments.§—The resistance shown by the living spores, of e. g. *B. anthracis* and *subtilis*, to the inception of watery solutions of anilin dyes, says Herr H. Buchner, disappears, as is well known, after their death. A similar condition of things is presented by the vegetative cell, and the behaviour of these cells to watery solutions of anilin pigments opens up several interesting questions.

Three series of experiments are given, in all of which methyl-violet

* Rivista Internaz. d'Igiene, i. (1890) pp. 1–3. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 798.

† Arch. f. Exper. Pathol. u. Pharmakol., xxvi. p. 341. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 477.

‡ Zeitschr. f Hygiene, vi. (1889). See Bot. Centralbl., xlii. (1890) pp. 273–4.

§ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 733–6.

was the pigment used. In the first series beer-yeast was the organism, and in the second and third the typhoid bacillus. The results with regard to the yeasts were that they showed, while alive, great resistance to the inception of dyes, but when killed, either by heat or by chloroform, they were easily stained.

The vegetative cells of the bacteria showed, it is true, a certain resistance, but the degree of this was very variable; that is to say, in some cases there was little or no difference between the dead and living cells, while in other instances it was (e. g. typhoid bacillus) very marked.

Another inference which the author derives, partly from his own experiments and partly from those of Birch-Hirschfeld with phloxin-red, is that the death of the vegetative cell is not necessarily associated with the inception of pigment, although it would seem, to us at least, that it is rather a question of time.

The experiment was as follows. Typhoid bacilli were incubated for 1 hour at 37° in methyl-violet solution 1 : 6000. At the end of this time all the bacilli were stained, and when 5 ccm. were cultivated on a plate, 63,000 colonies appeared. At the end of 2 hours only 10,450 colonies came up, and at the end of the third hour none. Of course this shows that the pigment becomes more and more noxious, and therefore possesses a disinfecting property.

Blue Milk.*—Herr L. Heim finds that the bacillus of blue milk is a short mobile rodlet with rounded ends, and, when stained, shows bright spots which do not impart the notion of their being spores. Neither endogenous nor free spores were observed in drop-cultivations, nor could the club-shaped form of this bacillus be verified by the author, but the interesting observation of the two distinct varieties, when cultivated on plates, was made. These varieties, though breeding true, behaved alike on all other points.

The most favourable for the pigment-formation was ordinary gelatin, to which 0·2–0·3 per cent. of lactic acid had been added; but potato was also a very suitable medium.

The tenacity of the bacillus was tested by drying blue milk, as a pure cultivation, on silk threads. After having been kept for 226 days, the pure cultivations were found to be viable, and the milk threads after 114 days.

To heat the bacilli are very little resistant, being killed in 10 minutes at 55°, and in 1 minute at 80°, a fact which argues against spore-formation.

Between 30° and 40° the bacteria developed no pigment, and their growth diminished on all media.

By the action of disinfecting media it was found that the bacteria were destroyed in 3 hours by 3 per cent., in 5 minutes by 10 per cent. soda solution, in 30 minutes by 1 : 300 salicylic, while boracic acid had no effect.

Anaerobic pyogenic Bacillus.†—M. Fuchs found in the pleural sac of a rabbit, which had died spontaneously, a large quantity of foul-

* Arbeiten aus d. Kaiserl. Gesundheitsamte, v. pp. 518–36. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 46–7.

† Inaug. Diss., Greifswald, 1890, 8vo, 30 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 11–12.

smelling pus, in which were rodlets 7–10 μ long and 0·75 μ broad. They were best stained with Loeffler's methylen-blue solution.

The bacteria grew best anaerobically between 36° and 38° C. in 10 per cent. gelatin, or in grape-sugar bouillon.

The cultivation gave off the same foul smell as was perceived in the pleural secretion. Inoculation experiments were for the most part a failure, although abscesses were sometimes found at the inoculation spot.

The method by which the author cultivated this anaerobic bacillus was very simple. A test-tube filled obliquely with Loeffler's blood-serum, having had the condensation water poured off, was inoculated, and then inverted over a stream of hydrogen gas from 1/2–1 minute.

The mouth of the tube was then quickly closed with a caoutchouc plug, then smeared with paraffin, and the tube left upside down. This method is not only simple, but quite successful for anaerobic cultivations.

Action of Reducing Agents on Anaerobic Bacteria.*—Messrs. S. Kitasato and Th. Weyl have examined the action of certain reducing agents on the growth of anaerobic bacteria by the bacilli of symptomatic anthrax, tetanus, and malignant œdema. Some of the reagents acted inhibitively; such were the hydrochlorate of hydroxylamin and of phenyl-hydrazin; and in a less degree chinon, acetaldehyd, and benzaldehyd. Others, such as resorcin, hydrochinin, eikonogen, and formate of soda, promoted growth; but the most active was one per cent. of sulph-indigotate of soda when added to the agar medium. As the culture increases the agar becomes decolorized, but on treating it with oxygen the blue colour returns; hence the growth produces the decoloration of a reducing process, and the authors therefore think they have hit upon a means of demonstrating reduction processes when they occur during the development of micro-organisms. Experiments with aerobic bacteria (typhus, cholera, anthrax) showed that they reduced either very little or not at all.

Spore-formation in Anthrax.†—Herr K. B. Lehmann has been able to controvert the widely accepted view about spore-formation in anthrax, from experiments made for the special purpose of demonstrating whether spore-formation were affected for the better or worse by exhausted cultivation media. The doctrine that anthrax required defective nutriment for spore-formation was first promulgated by Buchner, and accepted by all succeeding writers on his *ipse dixit*. The author finds that the contrary is really the case, and that spore-formation takes place far more luxuriantly and favourably on rich and unexhausted media than when the medium is poor or worn out. The experiments were made in two series. In the first, anthrax bacilli were cultivated on media the composition of which varied in nutrient quality, and in the second they were cultivated on media which had been previously used for growing anthrax. Such media were sterilized, neutralized, and the evaporation-water replaced.

Herr H. Buchner ‡ replies to the strictures of Lehmann by pointing out that the latter has quite misrepresented his views as to the cause of

* Zeitschr. f. Hygiene, viii. p. 41. See Zeitschr. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 12–3. † SB. Physik.-Med. Gesell. Würzburg, 1890, pp. 34–7.
‡ Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 1–6.

spore-formation in anthrax, owing possibly to the latter having obtained his information second-hand. It is, however, generally supposed that spore-formation in anthrax is in some way associated with the exhaustion of the nutritive medium, and this explanation has usually been fathered on Buchner. The latter now explains that he never meant to say that spore-formation was the result of defective nutrition, but the consequence of some defect or deficiency occurring in the medium. The author then refers to the experiments made by him to show that he knew the facts cited by Lehmann. It is, however, certain that Lehmann's position is that spore-formation in anthrax occurs in media rich in nutrient material, and not in that which is exhausted. The position is entirely different from that taken by the author, and, from other points of view, may be regarded as probably being the more correct of the two.

Morphology of Streptococci.*—In the report of the Local Government Board, 1888, Dr. E. Klein discusses the characters of nine species of *Streptococcus* cultivated in seven different ways, as well as the results obtained from inoculating these same organisms. These micro-organisms were cultivated in tubes and plates of agar and gelatin in peptonized bouillon, all of which media were slightly alkaline. The following points were specially noted:—the appearance of the cultivation a few days after inoculation; the greater or less rapidity of growth of the colonies; the shape of the colonies; their modifications of shape during development; their different appearances in different media; their morphology. By aid of the foregoing characters most of these *Streptococci* could be distinguished from one another. The author concludes that scarlet fever, puerperal septicæmia, and foot and mouth disease, are due to the action of a specific *Streptococcus.* He alludes to the question of what constitutes a species or variety in a pathogenic microbe, and of the possibility of a modification of physiological or pathogenic species. Now, the variations in the action of some of these *Streptococci* on milk goes to support the doctrine of Nägeli, according to which the different forms of Schizomycetes are but phases or variations of one or at most two or three different species. But some, while morphologically and culturably identical, or at least indistinguishable, show diverse and constant pathogenic functions.

Bacteria of Influenza.†—Prof. V. Babes has now concluded the investigation of thirty-one cases of influenza.

The chief motive for these researches seems to have been a desire to show that there exists a series of bacteria, which in their growth or in their shape approximate to, or are identical with Pasteur's sputum bacteria on the one hand, and on the other to *Streptococcus pyogenes.* But a careful examination of the numerous varieties found was surrounded by great difficulties, owing chiefly to their extreme polymorphism, and their tendency to involution and degeneration; and the author seems inclined to think that it is not sufficient to confine the examination to one or two species, such as have been described by various writers during the progress of the epidemic, but that the exami-

* Annales de Micrographie, iii. (1889) pp. 49–52.

† Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 460–4, 496–502, 533–8, 561–8, 598–606. See *ante*, p. 373.

nation should be made to extend to the secreta and the cadaver, a procedure which would involve an immense amount of trouble and care, and also to the discovery of micro-organisms present in the various organs alone, or in combination.

Yet he suggests that bacillus i. might be provisionally accepted as the cause of influenza, and, in conclusion, calls attention to two pathogenic bacteria found in the nasal fossæ.

The communication concludes with a tabular retrospect of the various micro-organisms found during the investigations, and is divided into two parts, the first of which deals with the bacteria of bronchitis, and the second with the streptococci, capsule-bacteria, and allied micro-organisms, found in influenza and its sequelæ. For the details of these experiments, which are both voluminous and important, we must refer to the original.

Herr J. Prior * has examined fifty-three cases of influenza, twenty-nine of which were uncomplicated, while in the remainder there was also pneumonia.

The Fraenkel-Weichselbaum pneumonia-coccus, *Staphylococcus pyogenes aureus*, and *Streptococcus pyogenes*, were constantly found in the secreta of the respiratory passages, and in the exudates of various organs. It was found that the pneumonia-cocci frequently preceded the *Streptococci*, which, having ousted the former, proceeded to undisturbed development, thus producing the phenomena of inflammation. The author, however, does not regard any of the three organisms as the exciting cause, but considers that the influenza simply prepares a favourable medium for their development.

Herr E. Levy † found in seventeen out of eighteen cases of influenza the *Diplococcus pneumoniæ* Fraenkel. The secretions examined were pus from the ear (otitis) and from the pleural sac (empyema); also serous pleural exudations and the catarrhal secretion from the respiratory tract. Besides this, *Streptococcus pyogenes* and *Staphylococcus pyogenes albus* were occasionally found. The results of this observer are worthy of notice on account of the predominating number of the pneumonia coccus, and interesting because at the time of the epidemic there was an unusual number of cases of croupous pneumonia in the place of observation (Strassburg).

Kowalski ‡ has examined sixteen cases of influenza, and from them isolated three hitherto unknown kinds of micro-organisms. (1) The first resembled the typhoid bacillus. The rodlets were easily stained, grew at ordinary temperature on potato, agar, and gelatin. The gelatin was liquefied and the colonies of a brownish hue. (2) The second variety formed snow-white colonies on the surface of the gelatin, which was liquefied. They were from 1–2 cm. in diameter, and only throve at low temperatures. (3) The third kind grew best in agar at incubation temperature, and in twenty-four hours appeared as colourless drops

* Münchener Med. Wochenschr., 1890, Nos. 13–15. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 705–7.

† Berlin Klin. Wochenschr., 1890, No. 7. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 711–3.

‡ Wiener Klin. Wochenschr., 1890, Nos. 13 and 14. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp 701–3.

about the size of a pin's head on the surface of the medium, which in forty-eight hours was coated with a firmly adherent layer. In 8–12 days the cultures died all at once. They would not thrive at ordinary temperatures and did not grow on potato, milk, or bouillon. Microscopically these colonies consisted of chains of *Diplococci* and they are denominated by the author jelly-streptococci. This micro-organism was found by the author seven times out of the sixteen cases, and the opinion is rashly expressed that had this microbe been discovered on every occasion there could have been no difficulty about accepting it as the exciting cause of influenza.

Besides the three unknown microbes, the author isolated *Staphylococcus pyogenes aureus*, *albus*, and *citreus*, *Diplococcus pneumoniæ* (Fraenkel-Weichselbaum), *Streptococcus pyogenes*, *Staphylococcus cereus*, *albus*, and *flavus*, and Friedlaender's pneumonia bacillus.

The cultivation medium was made by boiling one kilo of chopped-up calf's lung in 2 litres of distilled water and then adding to the expressed filtrate 18 grm. salt, 9 grm. phosphate of potash, 9 grm. sulphate of ammonia, 25 grm. sulphate of soda, 90 grm. sugar, 25 grm. pepton, and 50 grm. gelatin. When these ingredients were quite dissolved 10–15 per cent. gelatin or two per cent. agar, thoroughly macerated, was added, and the whole boiled to a perfect solution. It was then neutralized with equal parts of caustic potash and soda, and afterwards diluted with $2\frac{1}{2}$ litres of distilled water. Having been cooled down to 58° it was cleared up with the whites of four hen's eggs and then boiled up again for a few minutes previous to being passed through a hot-water filter. To the filtrate 8–10 per cent. glycerin was added and then distributed into test-tubes and flasks, wherein it underwent discontinuous sterilization.

Herr Ribbert,* in a series of further observations on influenza, has constantly found *Streptococcus pyogenes* and once only associated with a coccus which appeared to be a modification of *Diplococcus pneumoniæ*. He is therefore more than ever convinced that this micro-organism has some causal connection with influenza, and also opines that the epidemic agrees in many points with erysipelas. The coccus was always easily demonstrated by cover-glass preparations and also after cultivation.

Dr. Marmorek,† in an examination of the bronchial secretion of eight cases of undoubted influenza, found in seven a micro-organism resembling the Fraenkel-Weichselbaum coccus. In only one case could the diplococci not be demonstrated. In six cases there developed on agar plates colonies about the size of poppy-seeds, of irregular shape, of great firmness, of a blackish-brown colour and with indented outline. These cocci were stainable by Gram's method, and formed chains of two to forty individuals. These bacteria did not grow on gelatin, but did so on agar and on bouillon. The cultivations lasted only a short time. They were not pathogenic to animals.

The author does not regard this micro-organism as being the exciting cause of influenza.

* Deutsche Med. Wochenschr., 1890, No. 15. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 700–1.

† Wiener Klin. Wochenschr., 1890, Nos. 8 and 9. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 509–10.

Streptococcus and Influenza.*—M. Vaillard states that in two fatal cases of influenza he has found *Streptococcus* in the blood and organs: in one case, in blood of the cephalic vein and in the lung-juice; in the other case, in which there were pleurisy and pericarditis, in the pericardium, in the blood, and in the splenic juice. These two make altogether six fatal cases in which the author has found this micro-organism, either alone or associated with *Staphylococcus pyogenes aureus.* In the excreta and secreta of the living the *Streptococcus* was always found, but never in the blood. Inoculation of white mice with this *Streptococcus* proved fatal in 3–5 days, and it was afterwards found in the blood and in the organs.

Inoculation in rabbits resulted in redness with œdema; and if injected into the circulation death in 8–14 days ensued, changes being found in the pleuræ, pericardium, or in the lungs. The author considers the *Streptococcus* to be identical with *S. erysipelatis.*

Bacteria with Mycele.†—Herr E. Almquist describes three different bacteria belonging to the genus *Streptothrix* Cohn, which were found to possess characters common to fungi and schizomycetes.

The first of these was isolated from a gelatin cultivation of some unknown bacillus. It liquefied gelatin, forming thin flakes, which consisted of very fine non-septate branched filaments about 1 μ thick. Grown in bouillon, the mycele produced small round bacillus-like cells, from which again a new mycele sprang up.

The second *Streptothrix* was found in a plate-cultivation of pus from the base of the brain of a gunner dead of cerebro-spinal meningitis. These slowly liquefied gelatin, forming crusts, which consisted of long non-articulated branched filaments 1/2–1 μ thick. The filaments develope small oval or cuboidal cells (spores). These germinate in such a way that from either end one to four processes may sprout out, developing into filaments. The third kind was found in the water supply of Göteborg. On gelatin and agar it formed thin wrinkled whitish crusts, which consisted of delicate filaments. This variety did not produce any bacillus-like cells, but was characterized by many small branches interposed between the filaments.

Influence of Sunlight on Micro-organisms.‡—Sig. S. Pansini, in experimenting with sunlight in order to ascertain the influence exerted on the growth and development of micro-organisms, used cultivations of *Bacillus prodigiosus violaceus, pyocyaneus, anthracis, choleræ, murisepticus,* and *Staphylococcus pyogenes albus.* Recent inoculations and mature cultivations of these bacteria in agar or potato were exposed to sunlight, some of the tubes being protected from the solar action by being covered over with a blackened bell-jar. The temperature to which the tubes were exposed varied usually from 30° to 40°, but occasionally 45° were registered.

The conclusions arrived at were that even diffused light has a retard-

* La Semaine Méd., 1890, No. 7. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 408.

† Zeitschr. f. Hygiene, viii. (1890) pp. 189–97. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 141–2.

‡ Rivista d'Igiene, 1889. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 107–9.

ing action on the development of micro-organisms; that direct sunlight possesses an effective sterilizing action on micro-organisms, and also retards their development; that this sterilizing action is most powerful when the sun's rays fall perpendicularly to the surface of the cultivation; that the sterilizing and inhibitory action varies, as to time, with different micro-organisms and with the cultivation medium; cultivated in bouillon, anthrax-spores resist the action of light about equally or rather less than the bacilli; that spores are killed by light, as spores and not as young bacilli; that light retards, but does not prevent spore-formation; that it modifies the production of pigment, usually diminishing the quantity, but sometimes the quality; that it attenuates the virulence of anthrax.

Morphology and Biology of Streptothrix Foersteri Cohn.*—Dr. G. Gasperini describes at some length his experiments with *Streptothrix Foersteri*, an organism first described by Cohn. It was originally found in the concretions of the inferior lacrymal canal, but was afterwards discovered to be quite an ordinary inhabitant of the air of dwelling-houses.

After describing how it grows on various media the author discusses its evolution cycle. The microbe is practically aerobic, for though it will throw out filaments in the absence of oxygen, the presence of this gas is necessary for the development of spores. The temperature most adapted for its growth is between 30° and 37°.

No sensible effect was found to be exerted either on the mycelium or spores by diffused light, while direct sunlight had either an inhibitive or pernicious action. It would seem also that *S. Foersteri* is best cultivated in alkaline or neutral media, which are rendered acid by its development; it is able to live as a parasite on fungi, but does not appear to have much pathogenic action when injected into rabbits or guinea-pigs. Illustrations are given to show the character of the growth in gelatin, &c., and the appearance of the micro-organism under high powers. Here it is represented as a septate mycele, the filaments of which frequently end in a chain of small cells (spores.)

Phases in the Development of the Cholera Microbe.†—Mr. G. F. Dowdeswell describes at length, under the head of phases in the development of the cholera microbe, a series of forms which were obtained by cultivating in moist heat and observed directly under the Microscope. The forms in question are morphological varieties due chiefly to altered conditions of environment, and hence it is possible that this alteration affords an explanation of the absence of the characteristic commas in some cases of cholera. At any rate the author's observations go far to confirm the opinions of Naegeli, expressed thirteen years ago; these were to the effect that the shape of schizomycetes is only invariable for similar external conditions.

The forms described by the author are depicted in an illustration accompanying his paper, and are drawn under magnifications of 800 to 1500. The shapes vary from small globules to large globules, with or without vacuoles, from ovoid and bacillus-like to amœboid masses of

* Ann. de Micrographie, iv. (1890) pp. 449–74 (3 pls.).
† T. c., pp. 529–44 (1 pl.).

protoplasm. It is this amœboid condition showing the plasticity of juvenile protoplasm, which makes the author's observations so interesting.

Bacteriological Examination of Drinking Water in Christiania.*— Herr L. Schmelck gives in chart form the result of his bacteriological examination of the drinking water of Christiania for the years 1888 and 1889. The chart shows that in May and April the number of bacteria found in the water are enormously in excess of what occur at other periods of the year. This increase coincides with the time of the melting of the snow; in other words, there is a direct relation between the spring melting of the ice and snow and the number of bacteria found in running water. The author considers that the explanation of their presence is that the bacteria are swept away from the upper layers of the surface-earth by the snow-water; a similar result ensues after heavy falls of rain. About 30 species of bacteria, some of which were invariably present, while others only appeared at certain seasons, and a few cropped up occasionally, were isolated from the Christiania water.

Chemical analyses of this water were made during the same period as the bacteriological examination, but no connection between the results was observable, except that traces of ammonia were present in the water at times when it contained the largest quantity of micro-organisms.

Germicidal Action of Blood.†—Prof. A. Bonome, in endeavouring to ascertain how far experimental conditions altered the value ascribed to the results obtained in researches on the germicidal action of the blood, made use of pyogenic micrococci and the intravenous injection of water. That is, he used pus of various ages and conditions (acute and chronic abscesses), and diluted the blood with water by injections into the circulation. By using the pure, but old, pus virus (obtained by filtering through porcelain), it was found that the virus increased the germicidal action of the blood towards *Staphylococcus aureus*, *albus*, and *citreus*, but had no influence on the tissues. With fresh pus (acute abscess) the results were quite different, and the virus did not increase the germicidal efficiency of the blood, and diminished that of the tissues. When sterilized virus from cultivations of various pyogenic cells was used, an acquired immunity resulted, and this is ascribed to the greater resistance of the tissue-elements from custom and association.

With regard to the intravenous injection of water, it is only necessary to remark that this procedure considerably diminished the germicidal action, but was not able to suspend it altogether. This seems to depend on the loss of the saline constituents and the deficiency of oxygen.

Prof. H. Buchner‡ has long upheld the virtues of the blood-serum as a germicide, and recently, in conjunction with F. Voit, G Sittmann, and M. Orthenberger, made experiments to show that not only does blood possess a germicidal action, but that this action is due, chiefly at least, to the serum. The method by which these results are obtained is in prin-

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 102–6 (1 fig.).

† T. c., pp. 199–203, 234–8.

‡ Arch. f. Hygiene, x. (1890) pp. 84–173. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 183.

ciple quite simple. It merely consists in inoculating pure blood or serum with micro-organisms, and noting the number of colonies or individuals which appear from time to time or at certain intervals after inoculation. The results obtained by these experimenters tend to show that serum and defibrinated blood are quite capable of killing germs, so long as they—the serum and blood—retain their vital action. If, however, their constitution be altered or impaired by the addition of certain substances, or the subtraction of certain constituents by altered environment or physical condition, then the germicidal action also is altered, and this alteration is usually for the worse.

The main inference from these experiments, and that for which they were probably instituted, is to show that the doctrine of phagocytes is untenable, or, at any rate, is not required to explain certain germicidal phenomena.

Prof. Koch's Remedy for Tuberculosis.—If, as we sincerely hope, Prof. Robert Koch has succeeded in discovering a remedy for tuberculosis, our Journal should contain a record which will be permanent, as compared with the reports which the Fellows have read in the daily newspapers. We give, therefore, copious extracts from Dr. Koch's "further communication," published in the 'Deutsche Medizinische Wochenschrift,' of Nov. 14th, and translated in a supplement to the British Medical Journal' of Nov. 15th, 1890.

"In an address delivered before the International Medical Congress I mentioned a remedy which conferred on the animals experimented on an immunity against inoculation with the tubercle bacillus, and which arrests tuberculous disease. Investigations have now been carried out on human patients, and these form the subject of the following observations.

It was originally my intention to complete the research, and especially to gain sufficient experience regarding the application of the remedy in practice and its production on a large scale before publishing anything on the subject. But, in spite of all precautions, too many accounts have reached the public, and that in an exaggerated and distorted form, so that it seems imperative, in order to prevent all false impressions, to give at once a review of the position of the subject at the present stage of the inquiry. It is true that this review can, under these circumstances, be only brief, and must leave open many important questions.

Nature and Physical Characters of the Remedy.—As regards the origin and the preparation of the remedy I am unable to make any statement, as my research is not yet concluded; I reserve this for a future communication. The remedy is a brownish transparent liquid, which does not require special care to prevent decomposition. For use this fluid must be more or less diluted, and the dilutions are liable to decomposition if prepared with distilled water; bacterial growths soon develope in them, they become turbid and are then unfit for use. To prevent this the diluted liquid must be sterilized by heat and preserved under a cotton wool stopper, or more conveniently prepared with a half per cent. solution of phenol.

Manner of Using the Remedy.—It would seem, however, that the effect is weakened both by frequent heating and by mixture with phenol solution, and I have therefore always made use of freshly prepared

solutions. Introduced into the stomach, the remedy has no effect; in order to obtain a reliable effect it must be injected subcutaneously. For this purpose we have used exclusively the small syringe suggested by me for bacteriological work; it is furnished with a small india-rubber ball, and has no piston. This syringe can easily be kept aseptic by absolute alcohol, and to this we attribute the fact that not a single abscess has been observed in the course of more than a thousand subcutaneous injections. The place chosen for the injection—after several trials of other places—was the skin of the back between the shoulder-blades and the lumbar region, because here the injection led to the least local reaction—generally none at all—and was almost painless.

Effect of Injections in Healthy Individuals.—As regards the effect of the remedy on the human patient, it was clear from the beginning of the research that in one very important point the human being reacts to the remedy differently from the animal generally used in experiments—the guinea-pig—a new proof for the experimenter of the all-important law that experiment on animals is not conclusive for the human being, for the human patient proved extraordinarily more sensitive than the guinea-pig as regards the effect of the remedy. A healthy guinea-pig will bear 2 cubic centimetres, and even more, of the liquid injected subcutaneously without being sensibly affected. But in the case of a full-grown, healthy man 0·25 cubic centimetre suffices to produce an intense effect. Calculated by body weight, the 1500th part of the quantity, which has no appreciable effect on the guinea-pig, acts powerfully on the human being. The symptoms arising from an injection of 0·25 cubic centimetre I have observed after an injection made in my own upper arm. They were briefly as follows:—Three to four hours after the injection there came on pain in the limbs, fatigue, inclination to cough, difficulty in breathing, which speedily increased. In the fifth hour an unusually violent attack of ague followed, which lasted almost an hour. At the same time there was sickness, vomiting, and rise of bodily temperature up to 39·6° C. After twelve hours all these symptoms abated. The temperature fell until next day it was normal, and a feeling of fatigue and pain in the limbs continued for a few days, and for exactly the same period of time the site of injection remained slightly painful and red. The lowest limit of the effect of the remedy for a healthy human being is about 0·01 cubic centimetre (equal to 1 cubic centimetre of the hundredth solution), as has been proved by numerous experiments. When this dose was used, reaction in most people showed itself only by slight pains in the limbs and transient fatigue. A few showed a slight rise of temperature up about to 38° C. Although the dosage of the remedy shows a great difference between animals and human beings—calculated by body weight—in some other qualities there is much similarity between them. The most important of these qualities is the specific action of the remedy on tuberculous processes, of whatever kind.

The Specific Action on Tuberculous Processes.—I will not here describe this action as regards animals used for experiment, but I will at once turn to its extraordinary action on tuberculous human beings. The healthy human being reacts either not at all, or scarcely at all—as we have seen—when 0·01 cubic centimetre is used. The same holds good

with regard to patients suffering from diseases other than tuberculosis, as repeated experiments have proved. But the case is very different when the disease is tuberculosis; the same dose of 0·01 cubic centimetre, injected subcutaneously into the tuberculous patient, caused a severe general reaction, as well as a local one. (I gave children aged from two to five years one-tenth of this dose—that is to say, 0·001 cubic centimetre; very delicate children only 0·0005 cubic centimetre, and obtained a powerful, but in no way dangerous, reaction.) The general reaction consists in an attack of fever, which, generally beginning with rigors, raises the temperature above 39°, often up to 40° and even 41° C.; this is accompanied by pain in the limbs, coughing, great fatigue, often sickness and vomiting. In several cases a slight icteric discoloration was observed, and occasionally an eruption like measles on the chest and neck. The attack usually begins four or five hours after the injection, and lasts from twelve to fifteen hours. Occasionally it begins later, and then runs its course with less intensity. The patients are very little affected by the attack, and as soon as it is over feel comparatively well, generally better than before it. The local reaction can be best observed in cases where the tuberculous affection is visible; for instance, in cases of lupus: here changes take place which show the specific antituberculous action of the remedy to a most surprising degree. A few hours after an injection into the skin of the back, that is in a spot far removed from the diseased spots on the face, &c., the lupus spots begin to swell and to redden, and this they generally do before the initial rigor. During the fever, swelling and redness increase, and may finally reach a high degree, so that the lupus tissue becomes brownish and necrotic in places. Where the lupus was sharply defined we sometimes found a much swollen and brownish spot surrounded by a whitish edge almost a centimetre wide, which again was surrounded by a broad band of bright red.

After the subsidence of the fever the swelling of the lupus tissue decreases gradually, and disappears in about two or three days. The lupus spots themselves are then covered by a crust of serum, which filters outwards, and dries in the air; they change to crusts, which fall off after two or three weeks, and which, sometimes after one injection only, leave a clean red cicatrix behind. Generally, however, several injections are required for the complete removal of the lupus tissue. But of this more later on. I must mention, as a point of special importance, that the changes described are exactly confined to the parts of the skin affected with lupus. Even the smallest nodules, and those most deeply hidden in the lupus tissue, go through the process, and become visible in consequence of the swelling and change of colour, whilst the tissue itself, in which the lupus changes have entirely ceased, remains unchanged. The observation of a lupus case treated by the remedy is so instructive, and is necessarily so convincing, that those who wish to make a trial of the remedy should, if at all possible, begin with a case of lupus."

Dr. Koch next discussses the "local and general reaction to the remedy," "the diagnostic value of the method," and "the curative effect of the remedy."

Its Action on Tuberculous Tissue.—In what way this process occurs cannot as yet be said with certainty, as the necessary histological

investigations are not complete. But so much is certain that there is no question of a destruction of the tubercle bacilli in the tissues, but only that the tissue inclosing the tubercle bacilli is affected by the remedy. Beyond this there is, as is shown by the visible swelling and redness, considerable disturbance of the circulation, and, evidently in connection therewith, deeply seated changes in its nutrition, which cause the tissue to die off more or less quickly and deeply, according to the extent of the action of the remedy.

To recapitulate, the remedy does not kill the tubercle bacilli, but the tuberculous tissue; and this gives us clearly and definitely the limit that bounds the action of the remedy. It can only influence living tuberculous tissue; it has no effect on dead tissue, as, for instance, necrotic cheesy masses, necrotic bones, &c., nor has it any effect on tissue made necrotic by the remedy itself. In such masses of dead tissue living tubercle bacilli may possibly still be present, and are either thrown off with the necrosed tissue or may possibly enter the neighbouring still living tissue under certain circumstances. If the therapeutic activity of the remedy is to be rendered as fruitful as possible, this peculiarity in its mode of action must be carefully observed. In the first instance, the living tuberculous tissue must be caused to undergo necrosis, and then everything must be done to remove the dead tissue as soon as possible, as, for instance, by surgical interference. Where this is not possible, and the organism can only help itself in throwing off the tissue slowly, the endangered living tissue must be protected from fresh incursions of the parasites by continuous application of the remedy.

The Dose.—The fact that the remedy makes tuberculous tissues necrotic and acts only on living tissue, helps to explain another peculiar characteristic thereof, namely, that it can be given in rapidly increasing doses. At first sight, this phenomenon would seem to point to the establishment of tolerance, but since it is found that the dose can, in the course of about three weeks, be increased to 500 times the original amount, tolerance can no longer be accepted as an explanation, as we know of nothing analogous to such a rapid and complete adaptation to an extremely active remedy. The phenomenon must rather be explained in this way, that in the beginning of the treatment there is a good deal of tuberculous living tissue, and that consequently a small amount of the active principle suffices to cause a strong reaction; but by each injection a certain amount of the tissue capable of reaction disappears, and then comparatively larger doses are necessary to produce the same amount of reaction as before. Within certain limits a certain degree of habituation may be perceived.

As soon as the tuberculous patient has been treated with increasing doses for so long that the point is reached when his reaction is as feeble as that of a non-tuberculous patient, then it may be assumed that all tuberculous tissue is destroyed. And then the treatment will only have to be continued by slowly increasing doses and with interruptions, in order that the patient may be protected from fresh infection while bacilli are still present in the organism.

Whether this conception and the inferences that follow from it be correct the future must show. They were conclusive, as far as I am concerned, in determining the mode of treatment by the remedy."

Details are then given as to the treatment of lupus, tuberculosis of bones and joints, and of phthisis, from which we will only quote two paragraphs.

"The action of the remedy in cases of phthisis generally showed itself as follows:—Cough and expectoration generally increased a little after the first injection, then grew less and less, and in the most favourable cases entirely disappeared; the expectoration also lost its purulent character and became mucous.

As a rule, the number of bacilli only decreased when the expectoration began to present a mucous appearance; they then from time to time disappeared entirely, but were again observed occasionally until expectoration ceased completely. Simultaneously the night sweats ceased, the patients' appearance improved, and they increased in weight. Within four to six weeks patients under treatment for the first stage of phthisis were all free from every symptom of disease, and might be pronounced cured. Patients with cavities not yet too highly developed improved considerably, and were almost cured; only in those whose lungs contained many large cavities could no improvement be proved objectively, though even in these cases the expectoration decreased, and the subjective condition improved. These experiences lead me to suppose that *phthisis in the beginning can be cured with certainty by this remedy*."*

BAUMGARTEN AND OTHERS.—**Jahresbericht üb. die Fortschritte in der Lehre v. den pathogenen Mikro-organismen, umfassend Bakterien, Pilze u. Protozoën.** Unter Mitwirkung mehrer Fachgenossen bearb. u. hrsg. v. P. Baumgarten. (Annual Report on the progress of our knowledge of Pathogenic Micro-organisms, inclusive of Bacteria, Fungi, and Protozoa. 4th year.)
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„ „ **Contribution à l'étude des phagocytes.** (Contribution to the study of phagocytes.) T. c, pp. 432–9.

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* "This sentence requires limitation in so far as at present no conclusive experiences can possibly be brought forward to prove whether the cure is lasting. Relapses naturally may occur; but it can be assumed that they may be cured as easily and quickly as the first attack. On the other hand, it seems possible that, as in other infectious diseases, patients once cured may retain their immunity. This, too, must for the present remain an open question."

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„ G.—**Ueber die Einwirkung des künstlichen Magensaftes auf pathogene Mikro-organismen.** (On the action of artificial gastric juice on pathogenic micro-organisms.) *Archiv f. Hygiene*, X. p. 283.

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WINOGRADSKY, S.—**Recherches sur les organismes de la nitrification.** (Researches on the organisms of nitrification.)
Annal. de l'Institut Pasteur, 1890, pp. 257-75.

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Ejened. Klin. Gaz., 1889, pp. 595, 621, 650 (Russian).

MICROSCOPY.

α. Instruments, Accessories, &c.*

(1) Stands.

Bachmann, O.—**Unsere modernen Mikroskope und deren sämtliche Hilfs- und Nebenapparate für wissenschaftliche Forschungen.** Ein Handbuch für Histologen, Geologen, Mediziner, Pharmazeuten, Chemiker, Techniker, und Studierende. (Our modern Microscopes and their accessories for scientific inquiries. A handbook for histologists, geologists, medical men, pharmaceutical and other chemists, technical and general students.) München and Leipzig, 1890.

Errera, L.—**Microscope d'excursion de M. Amrhein.** (Amrhein's Travelling Microscope.) *Bull. Soc. Belge de Micr.*, XVI. (1890) p. 48.

(2) Eye-pieces and Objectives.

On Glass-smelting for Optical and other Scientific Purposes.†—Dr. Schott gives an account of the attempt, undertaken by himself and Prof. Abbe, to determine the mutual relations of optical effect and chemical composition for all possible amorphous compounds produced by solidification after fusion. It is now seven years since the idea of the work was first entertained. A year after the commencement of the undertaking sufficient data had been acquired to render it possible to predict that a systematic investigation of the question would lead to a considerable advance in practical optics. A building in Jena, suitable for carrying out the experimental work, was placed at the author's disposal, and was provided with furnace, blast, &c. Here, during the next two and a half years, the chief practical work of the investigation was effected. What remained to be done was to render the results obtained of service to practical optics. In furtherance of this design it was decided to once more renew in Germany the production of optical glass. This industry had been brought to a high state of perfection by Fraunhofer, but was, after his death, allowed to languish. It was foreseen that a long and costly series of experiments would be required before success could be attained, and that little aid could be expected from foreign sources. A grant of 60,000 marks from the Prussian Government, supplied on patriotic as well as on scientific grounds, met the cost of the apparatus for the first two years.

Fraunhofer had made experiments on the improvement of optical glass with much success. After his death, an English clergyman named Harcourt was the only one who undertook experiments of a similar kind, but the results obtained, although of interest, were of no practical utility. The following passage in a communication on the optical resources of the Microscope made by Prof. Abbe to the Exhibition of Scientific Apparatus in London in 1876, shows the condition of optical glass-smelting at that time:—

"It is not difficult to determine the fundamental grounds from which this want arises. The impossibility of getting rid of the chromatic differences of spherical aberration is dependent on the fact that, with

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Central-Ztg. f. Optik u. Mech., x. (1889) pp. 221–3, 232–4.

the crown and flint glass now at our disposal, the dispersion always goes hand in hand with the mean refractive index, so that the higher dispersion always belongs to the higher index, and *vice versa*. The aberration would be completely or at least approximately compensated if we possessed materials in which a relatively low refractive index was combined with a high dispersion, or a high refractive index with a relatively slight dispersion. It would then be possible, by a suitable combination of such a material with the ordinary crown and flint glass, to remove the chromatic and spherical aberration independently of one another, and thus to fulfil the essential condition on which the removal of the chromatic difference depends."

The perfecting of delicate optical instruments appeared, therefore, to depend on an advance in the art of glass-smelting, so that it should be possible to produce glasses suitable for the removal of the secondary spectrum, in which dispersion and mean refractive index would be differently related than in the glasses then used.

The uniformity in optical properties which characterizes most kinds of glass is due to the small number of materials used in their manufacture, viz. silica, alkalies, limestone, lead, and, in lesser degree, clay and thallium. The great aim of the authors was to advance beyond these narrow limits, and, directed by a methodical study of the optical characters of various chemical elements, to make use of such as appeared suitable to the end they had in view. They were in their work chiefly guided by the following considerations:—

(1) The composition of the glass must be regulated so that it shall not have too strong an action on the walls of the containing vessel, and thus lead to the introduction of foreign matter.

(2) It must be kept homogeneous by energetic stirring while in the melted state, so that it may be free from striæ of different refractive indices to that of the main mass.

(3) It must be kept free from cloudiness, crystal formation, and blisters during the processes of melting and cooling.

(4) It must bear reheating up to the melting-point without cloudiness or crystal separation.

(5) It must be kept free from strain by a suitable process of cooling.

(6) It must offer sufficient resistance to atmospheric agencies, and especially must show no signs of hygroscopic properties.

(7) It must be colourless.

(8) It must have sufficient hardness to allow the grinding, polishing, and shaping of the refractive surfaces.

Only relatively few inorganic anhydrides give rise to amorphous bodies when fused with certain metallic oxides and cooled. Hitherto silica was the only one which answered the above requirements, but boric, phosphoric, and arsenic acids were known to give glassy bodies in certain of their compounds. The authors accordingly first turned their attention to phosphoric and boric acids, and combined them with a great number of metallic oxides, in order to discover a combination without hygroscopic properties. The fusions were conducted in quite small porcelain crucibles of 20 to 30 ccm. contents with an ordinary laboratory blow-pipe. In spite of constant stirring during the fusion, pieces of

glass of sufficient size and homogeneity for complete spectroscopic measurement could not be obtained in this way. Nevertheless, these small pieces afforded proof that the above acids yielded glasses of extraordinary variety, and thus showed that considerable gradations in refractive index and dispersion could be obtained by their use.

The next advance was to prepare larger samples of glass. For this purpose a Fletcher gas furnace was found to be of the greatest service. With this furnace a rise in temperature up to the melting-point of metallic nickel could be obtained in about a quarter of an hour. The furnace consists of the usual heating chamber made of firebrick, and, in addition, of a so-called injector burner. The latter is formed of an iron tube, with the end towards the furnace covered with wire gauze, and the other pierced by a twyer through which the compressed air is forced. A pressure of air of 4–8 cm. of mercury is sufficient to effect the complete combustion of the gas admitted through a side-tube. The wire gauze at the end of the tube prevents the flame from passing backwards and causing an explosion of the combustible mixture in the tube. With this apparatus samples of glass of 150 grm. weight, and, later, up to 10 and 25 kgrm., were obtained, and they were found to satisfy all requirements, not only for scientific, but also for practical purposes.

By these means the optical characters of a large number of metallic oxides and acids were soon recognized, and it was found possible to incorporate in the glass, in amounts above 10 per cent., twenty-eight other bodies besides the five hitherto used. These were:—boron, phosphorus, lithium, magnesium, zinc, cadmium, barium, strontium, aluminium, beryllium, iron, manganese, cerium, didymium, erbium, silver, mercury, thallium, bismuth, antimony, arsenic, molybdenum, niobium, tungsten, tin, titanium, uranium, and fluorine.

The first object of the investigation—the power of obtaining gradations in refraction and dispersion—was soon attained. For the removal of the secondary spectrum, however, only comparatively few elements were found to offer suitable variations from the ordinary course of the dispersion. Of these boric acid produced a contraction of the blue and widening of the red end of the spectrum, while fluorine, potassium, and sodium had an opposite effect. For all other elements the course of the dispersion was the same as with silicate glass. Accordingly, since the ordinary flint glass shows an extension of the blue end of the spectrum as compared with crown glass, as high a percentage of boric acid as possible must be incorporated with it in order to obtain a perfect compensating effect. Thus boric acid has become the fundamental constituent of all flint glasses destined to diminish the secondary spectrum. The conditions are less favourable when it is desired to effect the compensation by widening the blue end of the spectrum of a crown glass. Of the three elements—fluorine, potassium, and sodium—suitable for this purpose, the last can only be introduced into silicate glass in very small quantities, and the potassium in amounts not exceeding 25–30 per cent.; this is because of their hygroscopic effect.

The chief characteristic of phosphoric acid—that of yielding glasses of comparatively slight dispersion with high refractive index—was made use of to solve the problem; for it had been found that, with equal ratio of refraction and dispersion, glasses of higher refractive index showed

an extension of the blue end of the spectrum. Thus by the use of phosphoric acid for the crown glass and a glass containing a high percentage of boric acid for the flint, it was found possible to almost completely remove the secondary spectrum.

While introducing material to produce certain optical effects, an important point to be considered was the modification of the composition of the glass, so that its external characters should remain satisfactory. Thus with phosphates and borates the alkalies must be used very sparingly, or deterioration of the polished surfaces under the influence of the atmosphere is unavoidable. It was ascertained, however, that certain glasses, which in themselves were hygroscopic, could be made serviceable by the introduction of large percentages of clay, zinc oxide, or other compounds. Great care, nevertheless, had to be exercised in these cases, since, as a rule, very slight changes in the percentage composition were sufficient to induce a partial or complete crystallization. On this ground many of the apparently numerous possibilities of borate and phosphate glass had to be excluded. After surmounting various obstacles the authors succeeded in producing a series of phosphate-borate, and borosilicate glasses in small samples. For the phosphate, observation showed that magnesia, clay, and potash offered the least dispersion, so that a crown glass could be produced with dispersion far less than that seen in any yet made. The use of baryta with phosphoric acid in a crown glass caused a decrease of refractive index of 1·53 to 1·59, and at the same time gave a lower dispersion. An aluminium-sodium-baryta-borate gave a borate crown glass, whose ray-path is useful for many purposes. The borate flint glasses, containing as much as 50 per cent. of boric acid, were made by the addition of clay, zinc oxide, and barium oxide, to satisfy all requirements, and to show no sign of hygroscopic characters.

Apparatus for the production of material on a large scale had now to be prepared. A special form of stirrer had first to be devised. This was made of porcelain, and was provided with two cross-bars. Besides the ordinary motion of rotation, an up and down motion extending over 5–10 cm. was also simultaneously communicated to it by a special mechanism. In spite of this, apparently, very effective arrangement the homogeneity obtained was not sufficiently perfect to enable the greater part of the mass to be used in large pieces for telescopes. Corrosion of the porcelain of the vessel, evaporation from the upper surface, &c., caused groups of striæ to form in the last portion poured out of the crucible. Accordingly it was determined to replace the porcelain crucible and stirrer by a crucible of platinum of 3 litre contents, and a platinum stirrer weighing about 1½ kgm. The result was, however, at first peculiarly unsatisfactory; for, during the cooling, an extraordinary number of bubbles were developed, and after being used three or four times, the platinum of the crucible became brittle and cracked. Later experiments with a smaller and thicker platinum crucible, which showed no sign of cracks, and did not give rise to any gas-bubbles, proved the adaptability of platinum to the end in view. The use of platinum was only applicable to the borate glass, since phosphoric acid attacks the metal.

The problem of the removal of the secondary spectrum having been

satisfactorily settled by the production of the phosphate and borate glass, attention was now directed to the improvement of the ordinary silicate glass. By the introduction of boric acid, zinc oxide, magnesia, baryta, and clay, silicate crown and light flint glasses were obtained with very varied relations of refraction and dispersion. Many combinations of light crown glass and light baryta flint glass were found to be of great service in aplanatic constructions for photographic purposes: for, owing to their increased transparency for the chemically active rays and their slight dispersion, they gave plane and sharp images in the camera.

The effect of strain produced in glass on cooling had next to be considered. Ten years ago Dr. Schott had made some experiments in this direction in relation to the so-called "Hartglas." He proved that the hardening of the glass proceeds inwards layer by layer so that, the internal part solidifying later than the outer, a state of strain was induced which manifested itself by diminished specific gravity and phenomena of double refraction.

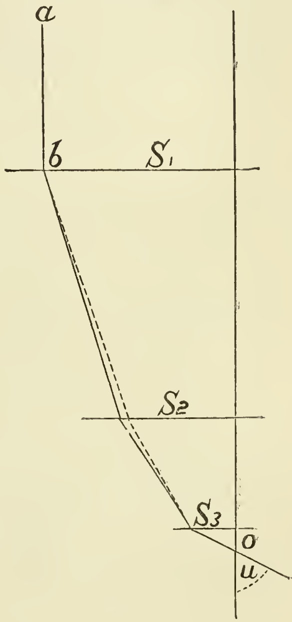
Now the lowering of the density of a substance is constantly accompanied by a diminution in the refractive index, so that this subject naturally becomes of the utmost importance in relation to delicate optical instruments. A strain becomes especially harmful when it is developed not in the centre of an objective, but excentrically. The effect of this is that the focal length varies in different parts just as if it were not spherical, but irregularly cut in the direction of the strain. Repeated experiments, made in the kind of furnace hitherto used, showed that the ordinary technical process of cooling no longer corresponded to the requirements of the improved kinds of glass. Accordingly, two years ago other experiments were undertaken. Success was attained by automatically regulating the source of heat to which the glass was subjected, and by very gradually allowing it to fall in temperature. Hitherto a thick cylindrical copper cauldron had been used as a cooling vessel. This was placed in the course of a large gas flame, and was connected with a mercury vapour pressure thermometer. In the improved form of apparatus, the expansion of the mercury was used not only to give the temperature, but also to regulate the flame. By this means it was possible to keep up a constant temperature over long periods of time, and also to effect a very gradual fall in temperature down to that at which experience has shown that the movement of the smallest particles ceases. The maximum temperature at which any of the glasses lost all signs of strain, and entered into a very slightly soft condition, was 465°; and on the other hand, the minimum temperature at which any of them hardened was about 370°. This fall of 95° was then extended over periods varying from a few days up to four weeks, and more successful results of cooling were obtained than by the old method under the most favourable conditions.

On the Removal of the Chromatic Difference of the Spherical Aberration in Microscope Systems.*—Dr. Arthur Kerber states that for systems of three lenses, the chromatic difference of the magnification is removed by having the upper lens under-compensated, and the middle one strongly over-compensated. By dispersion of the white ray *a b*

* Central-Ztg. f. Optik u. Mech., xi. (1890) pp. 217-9.

(fig. 83) in the upper under-compensated lens S_1, the blue ray (punctuated in the figure) cuts the middle lens S_2 at a shorter distance from the axis than the yellow. Consequently by sufficient over-compensation of the middle lens, the blue and yellow rays on emergence from the front lens can be made to converge to the same point a. Then the angle of convergence u for both rays is the same, and therefore the difference of the magnification is removed. In seeking to apply this method, however, it was found that the chromatic difference of magnification is so connected with the chromatic difference of the spherical aberration that a diminution of the one leads to an increase in the other. Tracing the path of a yellow and blue ray (very near to the axis) and the yellow and blue marginal ray from the eye-piece to the point of emergence from the front lens S (fig. 84), the two yellow rays $d\,o$ and $d\,o'$ and the blue circumpolar ray $f\,o$ converge to the same point on the axis, when the system is spherically and chromatically corrected for this. On the other hand, the blue marginal ray $f'\,o'$, in consequence of the chromatic difference of the spherical aberration, cuts the axis behind the point o (in o').

FIG. 83.



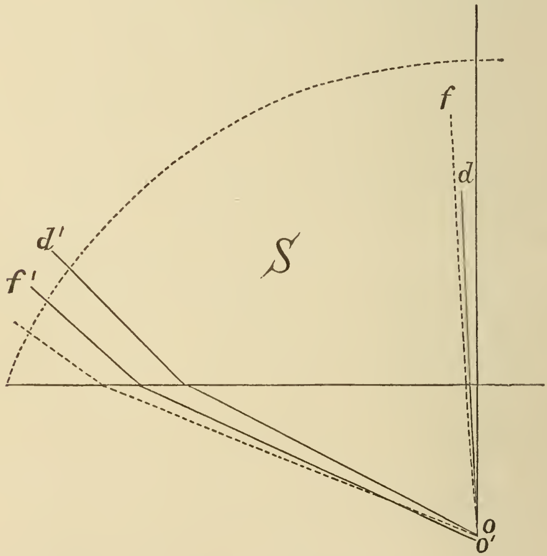
Now consider the system changed so that in the upper lens the dispersion of the crown glass is diminished, and that of the front lens increased, in both cases without change of refractive indices (for D). If this is done in such a way that the colour-aberration of the circumpolar ray is still removed, then the path of the two yellow rays suffers no change. On the other hand, the two blue rays, in consequence of the stronger over-compensation of the upper lens, cut the end face of the front lens at a greater distance from the axis than in the first system. By increasing the dispersion of the front lens, the blue circumpolar ray will cut the axis in the same point o as before, while the blue marginal ray, in consequence of the greater spherical aberration, cuts it in a point above o'. Accordingly, by sufficient over-compensation of the upper lens, the blue marginal ray can finally be also made to cut the axis in o.

Thus in systems of three or four members of determined form and refraction the chromatic difference of the spherical aberration is reduced by chromatic over-compensation in the hinder members, accompanied by increased dispersion of the front lens. But, as seen from the figure, this must produce an increase of sin u, so that the diminution of the spherical aberration of the blue rays goes hand in hand with an increase of the chromatic difference of the magnification and *vice versa*. The method of under-compensation of the upper lens (fig. 83) is therefore not to be

recommended, since by it a strong spherical aberration of the blue rays is produced which can in no way be removed by the eye-piece. An improvement in the geometrical focus is rather to be sought in the opposite direction, viz. by removing the spherical aberration of the blue marginal ray by means of the objective, and the resulting magnification error by a compensating eye-piece. In this way, if care be taken to remove the secondary colour aberration as much as possible, a completely colourless image can be obtained.

It is only possible to simultaneously satisfy many conditions in Microscope systems, by keeping the spherical and chromatic corrections distinctly separate. In order to be able to do this it is necessary to have at one's disposal a series of glasses with very varied dispersions for the

FIG. 84.



same refractive index. For, to correct for chromatic aberration a system already spherically corrected, without changing its form, glasses are necessary which have approximately the chosen indices and possess the dispersions determined by calculation.

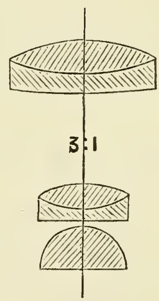
Since the diminution of the aberration of the blue marginal ray depends on the strong chromatic over-compensation of the hinder members of the system, the question arises whether the middle or the upper lens or both are to be over-compensated. Now a strongly over-compensated middle lens and *under-compensated* upper lens lead to a system (fig. 83) with slight difference of magnification and strong aberration of the blue marginal ray, while a strongly over-compensated middle lens and more or less chromatically *over-compensated* upper lens give a system with excessively under-compensated front lens. Thus strongly over-compensated middle lenses are to be avoided, and it is best

to combine a strongly chromatically over-compensated upper system with a strongly chromatically under-compensated front system.

As regards the choice of refractive indices for the individual lenses, fluor spar ($n = 1 \cdot 434$) is best for the convex lenses of the upper system, and for the concave, refractive indices (e.g. 1·57) which belong to a series of glasses of very varied high dispersions. For the middle lens, on the contrary, glasses with slight difference of dispersion, and as large as possible difference of the refractive indices, are to be chosen; and, finally, for the front lens a glass with strong colour aberration is to be used. The spherical correction of the system is made in the usual way. For the chromatic correction it is necessary to choose from a series of glasses with the determined indices those by which the colour aberration of the blue marginal and middle zone ray is removed, and at the same time the secondary aberration reduced as much as possible.

A Microscope System of 3·9 mm. focal length of Jena glass.*— Dr. Arthur Kerber has calculated the system he describes after the model of a 1/6 in., made by a well-known firm, with the idea of either establishing or altering the rules hitherto laid down for Microscope systems.

Fig. 85.



The marginal and central zone rays are of the wave-length 0·55 μ, and of height of emergence $h' = 2\frac{1}{2}$ and $1\frac{1}{4}$ mm., and the yellow and clear-blue rays are brought into union on the other side at the distance

$$h^* = 1 \cdot 9 \text{ mm. approximately.}$$

The elements of the system, represented in fig. 85, are given in the following table, in which r denotes the radius, d the thickness, y the air-space, and h' the half-aperture of the glass lenses, while No. 8, No. 39, and No. 38 indicate the kind of glass used in the lenses, and refer to the lists of the laboratory at Jena:—

	r.	*d.*	*y.*	*h'.*
Cover-glass (No. 8)	—	0·2455	—	—
Front lens (No. 8)	1·9	1·85	0·5383	—
Middle lens:—				
Flint lens (No. 39)	∞, − 4	0·8	0·1	—
Crown lens (No. 8)	+ 4, + 4	1·1	0	—
Upper lens:—				
Flint lens (No. 38)	32·5, − 5·5	0·8	4	2·5
Crown lens (No. 8)	5·5, + 7·5	1·45	0	2·5

The focal length of the system is 3·9 mm., the numerical aperture 0·65.

I.—The distance of union (z) and height of emergence ($h = z \tan u$) of the yellow rays, whose angle of inclination is determined by $\sin^2 \alpha$

* Central-Ztg. f. Optik u. Mech., xi. (1890) pp. 73–5, 86.

= 0·105, 0·210, 0·315, 0·420, are given with six-figure logarithms, as follows:—

$\sin^2 \alpha$	z_D	h_D
0·105	165·49	1·23589
0·210	162·86	1·74886
0·315	16[illegible]·47	2·14060
0·420	163·13	2·46455

If by the help of these data the distance of union is brought in the usual way into the form $Z = A - B\,h^2 + C\,h^4 - D\,h^6$, we have with the exactness to be attained by six-figure logarithms,

$Z_D = 171 \cdot 51 - 5 \cdot 307\,h^2 + 0 \cdot 9765\,h^4 - 0 \cdot 05431\,h^6$, and similarly:

$$Z_C = 175 \cdot 87 - 6 \cdot 087\,h^2 + 1 \cdot 0342\,h^4 - 0 \cdot 05906\,h^6.$$
$$Z_F = 166 \cdot 73 - 3 \cdot 827\,h^2 + 0 \cdot 9941\,h^4 - 0 \cdot 05164\,h^6.$$

From this follows the general expression for the distance of union of the system:—

$$\begin{aligned} (1) \quad Z = {} & A_1 + A_2(\lambda' - \lambda) + A_3(\lambda'^4 - \lambda^4) \\ & - [B_1 + B_2(\lambda' - \lambda) + B_3(\lambda'^4 - \lambda^4)] \,.\, h^2 \\ & + [C_1 + C_2(\lambda' - \lambda) + C_3(\lambda'^4 - \lambda^4)] \,.\, h^4 \\ & - [D_1 + D_2(\lambda' - \lambda) + D_3(\lambda'^4 - \lambda^4)] \,.\, h^6 \\ = {} & A - B \,.\, h^2 + C \,.\, h^4 - D\,h^6. \end{aligned}$$

where λ is the reciprocal of the wave-length in micra, $\lambda' = \lambda_{0 \cdot 55}$, and

$$\begin{array}{lll} A_1 = 169 \cdot 16 & A_2 = 45 \cdot 237 & A_3 = -1 \cdot 2 \\ B_1 = 4 \cdot 779 & B_2 = 5 \cdot 166 & B_3 = -0 \cdot 0395 \\ C_1 = 0 \cdot 9593 & C_2 = 0 \cdot 9774 & C_3 = -0 \cdot 03854 \\ D_1 = 0 \cdot 05218 & D_2 = 0 \cdot 06117 & D_3 = -0 \cdot 002018 \end{array}$$

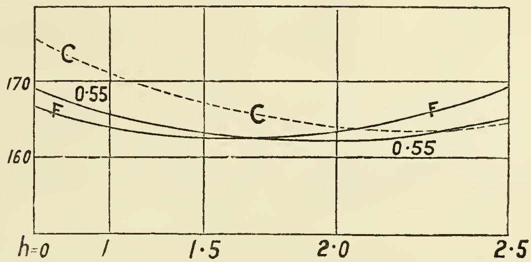
From this formula the distance of union of the rays C and F is calculated for $h = 0 \cdot 1, 0 \cdot 3, 0 \cdot 5$, and so on.

h	z_C	z_D	$z_{0 \cdot 55}$	z_E	z_F
0·1	175·81	71·46	69·11	67·99	66·69
0·3	75·34	71·04	68·74	67·64	66·40
0·5	74·41	70·25	68·03	66·98	65·84
0·7	73·13	69·14	67·04	66·07	65·09
0·9	71·59	67·83	65·90	65·03	64·26
1·1	69·94	66·45	64.72	63·98	63·49
1·3	68·36	65·07	63·57	63·00	62·86
1·5	66·74	63·90	62·67	62·28	62·57
1·7	65·49	63·02	62·10	61·93	62·73
1·9	64·60	62·52	61·95	62·04	63·44
2·1	64·07	62·44	62·26	62·64	64·75
2·3	63·87	62·73	63·01	63·72	66·67
2·5	63·81	63·23	64·03	65·13	69·04

In fig. 86 the path for the red, yellowish-green, and clear-blue rays is represented with h^2 (not h) as abscissa, and z as ordinate.

II.—The plane of the circle of least confusion of the brightest rays is reckoned as the focal plane of the system. Its position could then be determined, by the method of Aug. Kramer,* from the expression for the distance of union. But Kramer foresaw that the least section through the light-particles may be bounded by two zone-rays of opposite

FIG. 86.



inclination, and not always by a marginal and a zone-ray. Since, however, nothing definite can be known on this point, the author contents himself with determining the distance of the focal plane (ζ') from the simple relation $z = a - b\,h^2 + c\,h^4$.

The latter was deduced from the four-termed relation by the method of least squares. But z is to be so determined that the error of the transversal aberration

$$d\,\sigma = (z - \mathrm{Z})\frac{h}{z} = \frac{(a - \mathrm{A})\,h - (b - \mathrm{B})\,h^3 + (c - \mathrm{C})\,h^5 + \mathrm{D}\,h^7}{z}$$

shall be kept within the narrowest possible limits. This will be the case if the three maxima and the positive limit of that error determined by the marginal ray are equal to one another.

Now, in the function

$$y = m\,x + n\,x^3 + p\,x^5 + q\,x^7,$$

its positive limit (for $x = x'$), and its three maxima are equal to each other, for

$$m = -\frac{7}{64}\,q\,x'^6, \quad n = +\frac{7}{8}\,q\,x'^4, \quad p = -\frac{7}{4}\,q\,x'^2.$$

This introduced into $d\,\sigma$ leads to the determination

$$a - \mathrm{A} = -\frac{7}{64}\,\mathrm{D}\,h'^6, \quad b - \mathrm{B} = -\frac{7}{8}\mathrm{D}\,h'^4, \quad c - \mathrm{C} = -\frac{7}{4}\,\mathrm{D}\,h'^2;$$

or, since

$$\mathrm{A} = 169\cdot16, \quad \mathrm{B} = 4\cdot779, \quad \mathrm{C} = 0\cdot9593, \quad \mathrm{D} = 0\cdot05218, \quad h' = 2\cdot5:$$

$$a = 167\cdot77, \quad b = 2\cdot995, \quad c = 0\cdot3886,$$

so that

$$(2)\quad z_{0\cdot55} = 167\cdot77 - 2\cdot995\,h^2 + 0\cdot3886\,h^4.$$

* 'Allg. Theorie der Fernrohr-Objektive,' § 31.

From the following table it is seen that making use of this three-termed relation, the error of the transverse aberration $(z - Z)\, h : z$ is not greater than 3 μ.

h	$d\,\sigma$	h	$d\,\sigma$
0·3	− 2·2 μ	1·5	+ 3·0 μ
0.5	− 2·9	1·7	+ 2·7
0·7	− 2·7	1·9	+ 0·8
0·9	− 1·6	2·1	− 1·8
1·1	0	2·3	− 3·0
1·3	+ 2·0	2·5	+ 3·0

Thus in the correction of such a 1/6 in., it is justifiable to make use of the rules drawn from the three-termed relation, and to proceed by the same relation with the approximate determination of the focal plane.

The distance of this plane (ζ') is therefore found as follows:—Comparing

$$z = a - b\, h^2 + c\, h^4 \text{ and}$$

$$z = a - \beta\gamma \frac{h^2}{h'^2} + \gamma \frac{h^4}{h'^4},$$

we have $c = \gamma : h'^4$, $\gamma = c\, h'^4$: thus with central illumination ($h' = 1{\cdot}25$); $\gamma = 0{\cdot}949$; by use of all zones ($h' = 2{\cdot}5$); $\gamma = 15{\cdot}18$. Further we have from equation (2) as distance of union of the yellow-green rays of height of emergence $h^* = 0{\cdot}866\, h'$:

$$\text{for } h' = 1{\cdot}25 \qquad z^* = 164{\cdot}79$$
$$h' = 2{\cdot}50 \qquad 162{\cdot}27$$

and consequently, since $\zeta' = z^* + \frac{1}{16}\gamma$, as distance of the focal plane:

$$\text{for central illumination : } \zeta' = 164{\cdot}85$$
$$\text{by use of all zones : } \zeta' = 163{\cdot}22$$

The difference of 1·63 mm. corresponds to a lowering of the objective system (whose magnification N = 43) of $1{\cdot}63 : N^2 = 0{\cdot}0008$ mm. which is smaller than its penetrating power. For the rest see Dippel, 'Mikroskopie,' p. 344. The transverse aberration (σ) in the focal plane can now be calculated. It is given by the formula

$$\sigma = (z - \zeta')\frac{h}{z}.$$

1. For direct light ($\zeta' = 164{\cdot}85$):

h	σ_C	σ_D	$\sigma_{0\cdot55}$	σ_E	σ_F
0·1	+ 6·3μ	+ 3·9μ	+ 2·5μ	+ 1·9μ	+ 1·1μ
0·3	+18·1	+10·9	+ 6·9	+ 5·0	+ 2·8
0·5	+27·6	+16·0	+ 9·5	+ 6·4	+ 3·0
0·7	+33·7	+17·9	+ 9·2	+ 5·2	+ 1·0
0·9	+35·5	+16·0	+ 5·7	+ 1·0	− 3·2
1·1	+33·0	+10·6	− 0·8	− 5·8	− 9·1
1·3	+27·1	+ 1·7	−10·1	−14·7	−15·8

2. For two oblique cones ($\zeta' = 163 \cdot 22$):

h	σ_C	σ_D	$\sigma_{0 \cdot 55}$	σ_E	σ_F
0·1	+ 7·3μ	+ 4·9μ	+ 3·6μ	+ 2·9μ	+ 2·1μ
0·3	+20·9	+13·8	+ 9·8	+ 7·9	+ 5·7
0·5	+32·3	+20·8	+14·4	+11·3	+ 7·9
0·7	+40·2	+24·6	+16·0	+12·0	+ 7·9
0·9	+44·0	+24·8	+14·6	+ 9·9	+ 5·7
1·1	+43·6	+21·4	+10·1	+ 5·1	+ 1·8
1·3	+39·7	+14·6	+ 2·8	− 1·7	− 2·8
−1·3	−39·7	−14·6	− 2·8	+ 1·7	+ 2·8
−1·5	−31·6	− 6·2	+ 5·0	+ 8·6	+ 6·0
−1·7	−23·3	+ 2·1	+11·7	+13·5	+ 5·1
−1·9	−15·9	+ 8·2	+14·9	+13·8	− 2·6
−2·1	−10·9	+10·1	+12·4	+ 7·5	−19·5
−2·3	− 6·9	+ 9·2	+ 5·2	− 4·8	−45·4
−2·5	− 9·0	− 0·2	−12·4	−28·9	−86·7

The radius of the circle of least confusion (87 μ for F) is thus not greater than for telescope objectives of great focal length. Besides, with Microscope systems, the marginal zone is best used for resolution, i. e. for the representation of striæ, and for fine structures limitation of the illuminating cone (with change of adjustment) becomes necessary.

Further, the above table shows that for the yellow-green rays, with central illumination the maximum of the transverse aberration, and with the combined effect of all zones the two maxima, deviate somewhat from the positive limit. Thus, by change of the spherical correction (of B_1 in equation 1) and ζ', a further diminution of the spherical circle of least confusion can be obtained. On the other hand, the incomplete coincidence of the yellow and blue circles of least confusion is not to be removed by change of the chromatic correction (of A_2 in equation 1), because by lessening this error, for example, for direct light, it only becomes worse for the other forms of illumination. In order to obtain a distinct image in the focal plane, the rays with strong diffusion, which only form the ground on which the real image is seen, are completely cut off. These are:—

(1) All red rays since they are spread over ten times as large a surface as the image proper.

(2) The blue rays at distance 2·1 to 2·5 mm.

(3) The bright rays with great transverse aberration, which increases or diminishes rapidly and so produces a strong dispersion. These are the yellow rays of height of emergence 1·3 to 1·5 mm. and the green marginal rays.

On the other hand, the rays which take part in the production of the image are:—

(1) The weak rays with slight transverse aberration, which increases very slowly, so that there is a strong concentration of light. These are the blue rays at a distance of 0 to 2 mm.

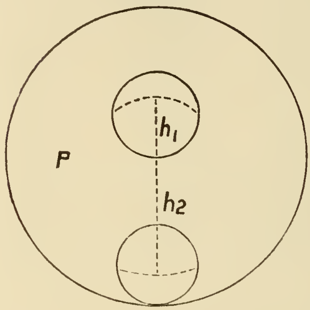
(2) The bright rays with great but slowly increasing aberration, e.g. the yellow-green rays of height of emergence 1·7 to 2·1 mm.

(3) The weak rays with small transverse aberration, even if this increases rapidly, e.g. the yellow marginal rays.

The image of a point with direct light is a disk of about 19 μ in diameter, surrounded by a pale yellow ring (on red and violet ground) about 8 μ broad.

For two oblique pencils, every individual image corresponding to the length of arc of the zone in the light parts of the "Austritts-pupille" is a circular arc of the same angular aperture.

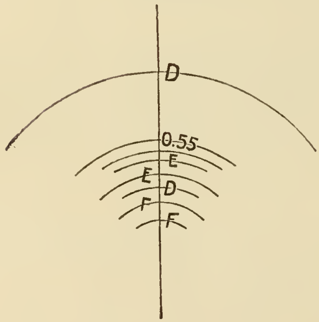
FIG. 87.



In the following table this angle (ϕ) is given for the zones 0·1, 0·3, 0·5, and so on.

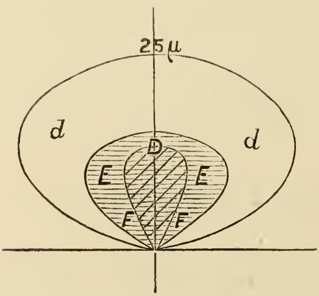
h	ϕ
0·1	166°
0·3	152°
0·5	134°
0·7	113°
0·9	88°
1·1	56°
1·3	18°
1·5	35°
1·7	39
1·9	38°
2·1	33°
2·3	25
2·5	0°

FIG. 88.



The image will be in this case represented by a number of arcs, which, with the transverse aberration σ, are inclosed in the angle ϕ, corresponding to the height of emergence. In order to simplify this representation of the image, those rays are to be taken in which the value of σ remains stationary, i. e. the maxima of the transverse aberration (e. g. $\sigma_D = 24 \cdot 8$ for $10 \cdot 1\ \mu$, $\sigma_E = 12$ for $13 \cdot 8\ \mu$).

FIG. 89.



Representing these as circular arcs, it is seen from the figure that with two oblique pencils the image is represented as a disc D E F with oval nucleus, which at E is coloured yellow-green, at D wine-yellow (yellow on red and violet ground), at F violet (blue and yellow-green predominating), and is surrounded by a large oval pale-yellow ring (*dd*).

The same result is obtained if the transverse aberration of all rays at the distance 0·1, 0·3, 0·5, &c., so far as they take part in the formation of the image, is represented by a number of circular arcs, and the

total image resulting in this way is divided into fields of different intensity.

The greatest diameter of the image proper D E F amounts to about 17, the greatest width of the pale-yellow border to 8 μ. A further concentration of the light is only possible by diminution of the effective aperture or of the object-distance.

Introduction of a Universal Scale of Magnification of Microscopical Figures.*—M. P. F. Reinsch complains that every micrographer makes use of an arbitrary scale for his figures. The camera obscura gives, for the same combination of objective and eye-piece, a constant magnification of the object figured; but the Microscopes of different makers differ widely, and the magnifications of the systems of objectives and eye-pieces do not vary in the same proportion. Consequently the statement as to the eye-piece and objective employed, made by authors on their figures, conveys little meaning to those who have not the same Microscope at their disposal.

In the systematic description of microscopical plants, it is of the utmost importance to give the dimensions in absolute value. For microscopical work such as this, the micron μ has been chosen as the unit of measure. A scale of magnification should be also based on the same unit. Measurements are indispensable in order to compare specimens of algæ and microscopic fungi with the published figures, but the work is complicated by the variety of magnifications used by authors, and long calculations are often necessary in order to find the absolute numerical values required.

To draw figures in conformity with the base of the measurements, the Microscope must be brought to the desired magnification.

Taking μ as unit, the following magnifications are recommended:—

Magnifications in μ.		Coefficients.	
2500	(dimens. of the figure) divided by	2·5	$= n\ \mu$ (absolute value).
2000	"	2	$= n\ \mu$
1500	"	1·5	$= n\ \mu$
1000	multiplied by	1	$= n\ \mu$
500	"	2	$= n\ \mu$
250	"	4	$= n\ \mu$
200	"	5	$= n\ \mu$
125	"	8	$= n\ \mu$
100	"	10	$= n\ \mu$

Only those coefficients are practicable which, multiplying or dividing 1000, give whole numbers as product or quotient. Magnifications greater than 1000 are obtained by multiplying, those less than 1000 by dividing 1000 by the coefficient. The above scale, which represents the magnifications which it is in this way possible to express in whole numbers, will answer all the requirements of microscopical figures.

* Bull. Soc. Bot. France, xxxvi. (1889) p. ccvii.

(3) Illuminating and other Apparatus.

Substages for Students' Microscopes.—The following interesting correspondence appeared in the pages of the 'English Mechanic':*—

"Under this heading Messrs. Watson and Sons reproduce, if I mistake not, a figure of the underpart of the stage of one of their Microscopes, which was published in the 'E.M.' a year or two ago. They appear to claim for it some originality of design, and bring it forward again, as if it wholly superseded the necessity for Swift and Sons' rival production, notwithstanding the fact that such rival production is recommended by the Secretary of the Quekett Microscopical Club (vide Report of Proceedings Q.M.C., 'E.M.,' p. 185).

Examining Messrs. Watson's figure with a somewhat experienced eye, I note that the substage is not mounted on a substantial tail-piece, but is merely connected with the stage proper by a screw, on which it pivots out of the axis, the axial position being roughly secured by a stop-pin; the centering is then effected by the two projecting screws on the circumference of the substage acting upon a movable inner ring or tube in which the condenser or other apparatus is applied.

This system of pivoting the substage has long been in use on the Continent for all classes of Microscopes, from the most elaborate down to the commonest types of so-called students' instruments. It is a bad system—bad in the Johnsonian "leg-of-mutton" sense—bad from every point of view.

A focusing and centering substage can hardly be too substantially connected with the Microscope, for it has to suffer more rough handling than any other part of the instrument. The fewer movements it has beyond those actually needed for use, the better; for every additional joint or slide-bearing brings in its quota of unsteadiness, making additional demands on the observer's watchfulness and patience in securing exactness of adjustment.

The only satisfactory arrangements of substage yet devised act by rack-and-pinion on a fixed tail-piece.

Many attempts have been made, both in Europe and America, to devise means for focusing the condenser of a less expensive character than the rack-and-pinion; but they have all been found radically bad in practice by those who were familiar with the conveniences of the rack-and-pinion, and who have been called upon to test the various systems devised in substitution.

In the older models of drum Microscopes (*Microscopes à tambour*) of Georges Oberhäuser—who was probably the first to apply mechanism to focus the substage condenser of the achromatic Microscope—the substage socket was a fixture beneath the stage, and the condenser tube sliding in it was provided with stud-pins on either side, on which a forked lever engaged, the free end of the lever projecting slightly through a vertical slot in the drum base, so that by its movement up or down the condenser was adjusted beneath the object. This arrangement was generally combined with some primitive means of centering the condenser with a screw-driver, such centering being on the "once for all"

* Engl. Mech., lii. (1890) pp. 228, 229, 251, 271.

principle, not to be altered during the process of observation, the very moment when it was most essential that it should be possible to alter it. In later constructions Oberhäuser applied a sort of gimbal to the forked lever to secure an easier sliding motion to the condenser for focusing; but the system of direct push or pull of the condenser tube within the substage socket, with or without gimbal, was always bad, and frequently ended in injury to the mechanism.

Nachet and others improved upon Oberhäuser's arrangement by applying under the stage a tail-piece having a dovetail groove in which a slide carrying the substage was actuated by a stud-pin and lever projecting laterally.

More recently, and particularly in America, the lever has been omitted by many opticians, and the microscopist has had to slide the fitting up or down the tail-piece by small knobs on either side. Even the most recent student's Microscope—that of Swift and Son, to which I have above referred—has this most inconvenient arrangement.

It would be too tedious to describe the various other systems that have been applied to avoid the expense of the rack-and-pinion. They consist generally of some form of screw-action, and probably the best of them is now made by a leading Paris optician.

Probably one of the worst focusing arrangements recently designed for the substage condenser is that proposed—if not invented—by Mr. E. M. Nelson. It consists of a substage socket fixed to the under face of the stage; a spiral slot is cut in the socket, in which a stud-pin on the side of the condenser tube moves up or down as this tube is rotated by hand. The focal adjustment of the condenser obtained by this motion in a spiral direction is very unsatisfactory. I suppose Mr. Nelson himself now recognizes its inferiority.

Until our opticians face the matter by applying the rack-and-pinion motion to a fixed tail-piece for students' Microscopes, I fear we cannot credit them with the serious intention of meeting the present requirements of students. It would appear that English makers are constantly handicapped by their own desire to supply a superabundance of "finish" in non-essentials, to the neglect of much-needed focal and centering substage adjustments, which every student would soon learn to appreciate.

If a beginner now asks the advice of an expert as to the microscopical outfit he should obtain, on explaining his requirements to the optician, he will probably be met at once with some such statement as follows:—"You can have a substage with rack-and-pinion and centering adjustments; but these things are only fitted to the better class of Microscopes commencing at the price of £x"—the *real* drift of which is to force the student into a larger outlay—to make what is commonly known in business as a "substantial transaction."

The fact seems to be that in England the manufacture of fairly good Microscopes is in the hands of so few opticians that they believe they can wholly control the trade. It is for responsible teachers in medical schools to combine and authoritatively formulate the *desiderata* of a student's Microscope—the laws of *demand* and *supply* will do the rest, though they should lead us to engage foreign opticians to drive English Microscopes of the students' class out of the field. Such a course does not seem patriotic; but I fear our opticians are proof against friendly

council on the matter. They can only be made to move in a popular direction when they find such firms as Zeiss's establishing themselves—as they are now doing—in London.

Microscopists naturally want the highest class of optical appliances they can acquire with the outlay at their disposal. They feel that inferior means conduce to inferior results only. The demand for the improved instruments—apochromatic objectives, compensating eye-pieces, projection eye-pieces, &c.—exists. The supply of these novelties by English opticians has been so extremely limited, and withal so tardy, that it has amounted to nothing of any importance, so we have to rely mainly on Zeiss, of Jena. That great firm, employing some four hundred people, has now established two representative houses in London, and it behoves our opticians to look to their laurels, for the competition promises to be the most serious that has occurred during this generation. Moreover, the competition will not be limited to the production of microscopical apparatus. The firm of Zeiss has now brought out a series of new photographic lenses which will, no doubt, demand and obtain the keenest attention of those who are interested in the progress of photography.—Microscopist."

"In submitting the student's Microscope, made by Messrs. Swift, at the last meeting of the Quekett Microscopical Club, I expressly disclaimed any idea of novelty in the parts of the instrument. My sole intent was to show how easily some better form of centering fitting could be applied in place of the makeshift understage tube, which is, *pace* Messrs. Watson, after all, the only thing provided in the vast majority of students' instruments. These gentlemen state that the form adopted by them in their Edinburgh model was designed by Dr. Edington, about two and a half years ago; but Messrs. Crouch have, for a much longer period, made a very similar form, and so has Reichert, of Vienna. The great drawback, in my opinion, to this arrangement is that it is in the way when turned aside; and, moreover, I do not think it can be contended that a substage supported by, and swinging on a single screw, is as steady and free from tremor as one with long bearings moving in a dovetailed guide. Mr. Nelson, whose criticism in these matters is always deserving of great respect, drew attention to the absence of a rack-and-pinion focusing adjustment in Messrs. Swift's instrument, but one is very easily fitted if required, and for the class of work this instrument is intended for it is by no means necessary.

I shall be very pleased if a discussion on this subject leads to the abolition of the non-centering substage tube, and the substitution of a more scientific arrangement, by whomsoever it may be designed.—George C. Karop."

"When writing previously on this subject we had no thought of inducing a controversy; but we must, in justice to ourselves, repudiate the inference of your correspondent, 'Microscopist,' that the substage of the Edinburgh Student's Microscope is not rigid. One would imagine, from your correspondent's letter, that it is a useless arrangement; but his information is evidently gleaned from the engraving that accompanied our previous letter, which he has not correctly interpreted, and certainly not from any practical working with one of our instruments. We would point out that when the substage is in the axial position, it fits into a

special collet, which grips it from beneath, so that there cannot be any shake; it is not merely 'roughly secured by a stop-pin,' as 'Microscopist' assumes. In fact, his remarks consist of an expression of superficial opinion, formed from an incorrect conception of the build of the instrument.

In proof of our assertion as to the rigidity of the form of substage, as fitted by us to the Edinburgh Student's Microscope, we may say that the sale of this class of instrument has now run into hundreds, and it is in frequent use by many leading microscopists, from whom we have received letters expressing great satisfaction with the rigidity of working parts. Further, a great deal of the demand for the instruments is from the very men that 'Microscopist' considers are best able to 'formulate the desiderata of a student's Microscope'—viz. the teachers in medical schools. From these, throughout the world, we have received orders, not only for ones and twos, but for "ties," and in nearly every instance the instruments have been preferred on account of their rigidity and the convenience and perfection of substage.

If any one required a substage on a fixed tail-piece we should supply it; but never, since we have made the Edinburgh Student's Microscope, have we been asked for such.—W. WATSON & SONS."

"Allow me to supplement my letter (see above) by a few observations, which I trust will forward improvements in the construction of students' Microscopes.

I have suggested that responsible teachers in medical schools should combine and authoritatively formulate the desiderata of a student's Microscope, and that the laws of demand and supply would do the rest.

On the question of the need of such combined action for this purpose, I hardly expect a dissentient voice. But as to the best means of bringing this action to a focus, that is matter on which I must only touch with diffidence. The fact that Mr. G. C. Karop, secretary of the Quekett Microscopical Club, avows his special interest in the subject would point clearly in his direction as a possible centre of action. No great difficulty should be found in forming a committee of men of similar tastes and aims, who would cordially strive to bring out a Microscope to meet the modern wants of students both as to efficiency and economy.

Such a committee would require the co-operation of a skilled mechanician, having considerable manufacturing resources at his command, and who would boldly face the outlay of developing what would be recommended. The prospect of the large business that would naturally follow upon the successful production of a student's Microscope, under such favourable auspices, would, no doubt, be quite sufficient to bring forward the right mechanician.

It may be asked why the requirements of students at this moment do not induce an optician to produce exactly what is wanted? On this it may be said that up to the present time the teachers in medical schools have never attempted any concerted action in the matter; they have been content, individually, to make suggestions here and there to the opticians, and these latter have only felt safe in carrying out the suggestions when they emanated from an influential man whose personal authority sufficed to insure a demand for the instrument large enough to

recoup the experimental outlay. Thus it has happened that each optician has had to secure for himself one or more of these patrons, each of whom has had his own pet schemes to promote, and there has been no sufficient inducement of probable commercial success to warrant the planning of the manufacture of Microscopes on a thoroughly economical basis, by which the most efficient instruments could be produced at a minimum price. The want of concerted action on the part of teachers has thus led to an immense waste of production—a waste amounting in many cases to 50 per cent. or more. It should also be noted that the optician is not, as a rule, catering directly for medical students; he has first to secure the good offices of an influential medical patron, who will instruct his pupils to purchase the apparatus he recommends. Unless, therefore, he is willing to forego his own independence of action, and carry out strictly the orders of his patron, the patronage is transferred to a more willing agent. It is wholly beside the mark to urge that the optician is not bound to follow such orders, that he may use his own discretion on the matter. In practice it may happen that Dr. Microtome, professor of microtomic biology at half a dozen medical schools, whose patronage is good for the sale of some scores of Microscopes per session, knows nothing whatever about the construction of Microscopes, or he may have just the smattering of interest in mechanical design that finds outlet in pressing forward novelties *quâ* novelties, regardless of their practical value; but he is keenly alive to the importance of having his name connected with some form of student's Microscope, and he knows the value of his patronage; the optician is, therefore, obliged to accept the terms proposed to him, and to produce Students' Microtomic Bacteriological Microscopes according to instructions. To add to the confusion of the circumstances, nearly every medical session is accompanied by changes in the medical staff; new ideas crop up or old ones are revived; the optician is appealed to for this or that petty modification in the design of the Microscope, and thus his skill and experience are too often frittered away in carrying out trumpery suggestions which would not stand a moment's discussion before a jury of experts. To meet this incessant order of change one optician in London has made upwards of twenty different forms of students' Microscopes during the past ten years.

My impression is that the present requirements of students do not really necessitate the construction of an entirely new design of Microscope, but only the combination or adaptation of a number of useful points which already exist either together or separately in known models. The student wants a stand that will enable him to get the best work out of his optical means. High-class instruments exist which appear to satisfy the demands of the most fastidious microscopists. It would appear, then, that there is no need for the invention of a new model: we want only the application of common sense to the process of selecting and embodying in the most economical way the points of construction which experience has shown to be the most essential in the high-class Microscopes.

It may be, however, that the majority of teachers in medical schools have no particular claim to be regarded as experts in the use of the Microscope, and hence that a committee of them would carry no very

special weight in their recommendations. A committee of this kind would naturally be guided to a great extent by the more experienced of the members; and these latter would not hesitate to call in the assistance of any one who was known to be specially qualified to advise on the matter—I think that might well be taken for granted.

With reference to the construction of students' Microscopes, where experience informs me that English opticians are very apt to go astray:—If we take a general survey of the various kinds of students' Microscopes produced in England, we shall be struck with the fact that they are too light in build, and consequently too liable to become loose and shaky in their bearings throughout. Take an average English stand of this class as it leaves the maker's hands, put it on a laboratory table to be used by students for a session or two, and it will then show such signs of wear and tear as to need radical renovation. This rapid deterioration of the mechanism of our students' Microscopes is, in great measure, due to the inferior quality of the metal employed, which is not selected for its durability, but mainly for its low price and the ease, and consequent cheapness, with which it can be fashioned. Thus instruments are put together with a considerable amount of accuracy in the bearings, and with rack-and-pinion work moving with all desirable smoothness, and, above all, with a most lustrous polish wherever the lathe can be brought to bear on the parts—the whole so artfully and cleverly finished that we are all deceived into commending the results. We examine critically all the movements and they pass muster with applause. But the question of the durability cannot be settled by mere inspection. We are apt to suppose that well-fitted metal-work must necessarily be durable because it *is* metal; whereas, durability depends to a very large extent on the quality of the metal. Many of these modern Microscope-stands are made of a quality of brass that is specially chosen of just that degree of hardness to enable the work to be done with the maximum speed, and, consequently with the minimum outlay on the production of the instruments. The question of durability is wholly ignored. The policy seems to have been to make the utmost haste in the business of manufacturing, and let 'the devil take the hindmost.'

Judicious concerted action on the part of class-teachers should put an end to this chaotic state of things, by giving the opticians reasonable assurance that those who can succeed in meeting the desiderata most efficiently will meet with the desired commercial success.

I have been informed, on reliable authority, that some months ago a project was discussed by sundry amateurs in London for a competition among opticians relative to the production of the most efficient Microscope-stands of certain classes, and substantial prizes were to be offered. The matter went so far that the secretary of one of the most prosperous societies in London was ready to inaugurate the competition formally. But wiser counsels prevailed. It was plainly foreseen that the difficulties of settling the conditions of the competition and the selection of the jury would lead to endless bickering and dissatisfaction, and so the matter was dropped.

The scheme we now have at heart is much less ambitious, and, I hope, more practical; and I think it should have the support of Mr. Karop and his fellow-workers.—MICROSCOPIST."

"The question between Messrs. Watson and myself relates to the advisability or not of retaining the pivoting movement of the mechanical substage in their Edinburgh Student's Microscope, as shown in the figure they reproduced with letter 31741, p. 207. They point to the numbers of these Microscopes sold in proof that the system must be good; whilst I, on the other hand, point to the mechanism itself in proof that the system is bad, and I will explain my views.

The chief aim in the application of focusing and centering movements to the substage is to enable the worker to adjust the illumination with all desirable accuracy. Experts have long been striving to popularize the fact that unless a mechanical substage is provided the student is placed at a serious disadvantage, for he cannot otherwise get the best work out of his optical battery.

In the most perfect Microscopes hitherto constructed, no efforts have been spared to make the mechanical substage thoroughly substantial and accurate, and its attachment to the main instrument as rigid as possible; hence the outlay on the substage is a large item of the total cost of these instruments.

In the less perfect Microscopes, which are also less costly, less expensive forms of mechanical substages have to be applied, and as the outlay is reduced, the construction naturally reaches a lower grade of general stability, until finally, in order to cut down the cost to the lowest point, the optician gives up the substantial connection of the fitting with the main instrument, and attaches the substage to the under face of the stage proper by a screw-pivot, as shown in Messrs. Watson's figure. The prime motive for adopting the pivoting system originally—I do not say the prime motive of Messrs. Watson, but of the real originators, the French or German manufacturers of low-class Microscopes for toy-shops, &c.—was to reduce the cost, for the attachment is of so inexpensive a character that I suppose it may be done for a shilling, and then carry a profit of 50 per cent. Such a system may be tolerable in toy Microscopes, where the substage is intended as a mere diaphragm carrier, and it was formerly much in vogue even for dissecting Microscopes, as made by Chevalier and others; but when the substage has to carry centering arrangements on a rack-and-pinion movement on a tail-piece, the whole purpose of these appliances is frustrated by the speedy development of 'wobble' and general instability that disgust the critical worker.

Good substage appliances are most essential adjuncts for all serious work, and they merit that the substage shall be soundly and substantially attached to the Microscope, with reasonable assurance that the condenser, &c., shall focus and centre accurately in the optic axis of the Microscope with the minimum of collimation error. These are the well-known conditions that should guide the optician in the application of an efficient substage to a student's Microscope; and they are not properly met by attaching it to the stage proper by a pivoting arrangement such as that figured by Messrs. Watson.

The student cannot too soon learn that the firmness of his mechanical substage, its rigid attachment to the Microscope, either by a tail-piece or other fitting, is infinitely more important in practice than the liberty of swinging it aside. He may take it for granted that the construction

of his low-priced substage will be quite unsteady enough in itself without the addition of a pivoting motion.

As to the pivoting system being recommended by Messrs. Watson's medical patron at "Modern Athens," that fact suggests to me only the probability that the recommendation is based on very limited experience of high-class work; whilst their own approval of it, according to the tone of their letter, seems largely due to commercial reasons which are not in my province to discuss.

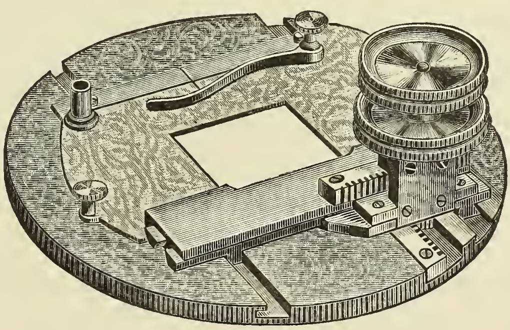
I condemn the system on its merits as totally unfit to be combined with a mechanical substage. I see in its application only the evasion of the recognized good and durable methods of attaching the substage to the Microscope, which are adopted wherever such matters have been seriously aimed at.

We have had, in all conscience, enough, with over-measure, of inferior constructions of students' Microscopes. Let us now aim at something altogether better.—MICROSCOPIST."

An Illuminating Cell.*—Mr. F. O. Jacobs describes a cell made of any white metal that will take a bright polish, and shaped so as to reflect the light it receives from the mirror to the object, which is mounted on an opaque ground. The cell completely covers the object but is perforated by an opening of the same size as the ground on which the object is mounted, which should be just large enough to inclose the field. The arrangement is completed with a small cover-glass. The advantage of this cell is, that it saves time in adjusting the light and condensing lens, the same lighting being used as with a transparent object.

Bulloch's Mechanical Stage with Vertical Pinions.—In the various constructions of this form of stage since its comparatively recent intro-

FIG. 90.



duction by the late R. B. Tolles, the mechanism has generally been defective in the matter of durability; in the endeavours to secure extreme thinness of the support for the slide, the attachment of the

* The Microscope, x. (1890) p. 281.

mechanism to the solid part of the stage has been so reduced in strength that with very little use it has become so loose and shaky as to be unserviceable.

In the new stage here shown (fig. 90) it has been the aim of Mr. W. H. Bulloch to correct the defects above noted by the application of dovetail slides to the forward and backward motions, which also provide a firmer support for the lateral motions.

(4) Photomicrography.

Photomicrography at Medical Congress of Berlin, 1890.*—In his review of the photomicrographic apparatus and photographs exhibited at Berlin during the sitting of the International Medical Congress, Dr. R. Neuhauss does not seem to have found much that was worth more than a general description. The well-known makers Zeiss, Leitz, Klönne and Müller, and Hartnack were, of course, in evidence with their well-known apparatus. A. Stegemann exhibited a base-board by which the camera could be moved from the horizontal to the vertical position; P. Thate, a magnesium flash-light apparatus; and Carl Günther, a cabinet for drying plates, capable of holding 24 plates 13 × 21 cm. in size. A strong current of air, kept up by means of a lamp fitted to the lid, dries the plates in 3 to 6 hours. Among the photographs may be mentioned those of Prof. Loeffler, showing the flagella of bacteria; the instantaneous photographs of living infusoria obtained with the flash-light of Duncker. The difficulty experienced with the ultra-violet rays was avoided by filtering through a Chinin filter. Prof. Babes, of Bucharest, is severely handled by the writer, who attributes to the photographs almost every possible fault. It would seem, however, that taken all round, photomicrography is greatly advancing.

Marktanner-Turneretscher's 'Photomicrography.'†—This recent manual on photomicrography is specially addressed to those who are desirous of showing the results of their own work by means of photography, and of attaining this object with the least expenditure of time and trouble. After reviewing and discussing the various apparatus necessary for photomicrography the author proceeds to the chief methods and explains the dry-plate, the wet-plate and the positive processes, and then indicates certain defects which frequently occur, and the means for their avoidance. The work ends with describing how to show photographic preparations by the aid of the magic lantern. The book is copiously illustrated, and contains an excellent list of works of reference.

Absorption-plates.‡—In order to absorb ultra-violet rays A. Miethe employs gelatin plates made as follows:—Gelatin 2 grm., glycerin 2 grm., water 25 ccm., æsculin 0·059. The gelatin is dissolved in 15 ccm. water, then are added the glycerin and the æsculin, dissolved in 10 ccm. water; the whole is then filtered through flannel. Glass plates are covered with a pretty thick layer of this mixture, which is then allowed to set and dry in a dust-free place. In order to completely absorb the ultra-

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 145–50.
† 'Die Mikrophotographie,' Halle, 1890, 344 pp., 195 engravings, and 2 pls.
‡ Photogr. Wochenbl., 1890, No. 18. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) p. 187.

violet rays, the æsculin plate is combined with another which contains 0·02 grm. of fluorescin instead of the æsculin. These two plates are stuck together and their edges united with black paper. As the æsculin becomes embrowned with time it must be replaced by a fresh plate.

Application of Photography to the demonstration of certain Physiological Processes in Plants.*—Mr. W. Gardiner states that it is possible, by taking advantage of their sensitiveness to light, to obtain prints from *Protococci*, or the free-swimming swarm-spores of many green algæ. Into one end of a water-tight box a thin glass plate is securely fixed. The negative to be printed is then placed next the glass, film side nearest. The box is filled with water containing a fairly large quantity of swarm-spores, and the lid is shut down and the whole exposed to diffused light. In the case of a strong well-developed negative, the swarm-spores swim towards the most highly illuminated parts, so that, after some four or six hours, on pouring out the water and removing the negative, a print in green swarm-spores can be obtained.

(6) Miscellaneous.

Deceased Honorary Fellows. Mr. Ralfs and Prof. Parker, F.R.S.—Our Fellows will be glad to have memorial notices of the two eminent honorary Fellows whom we have recently lost. That of Mr. John Ralfs is extracted from the notice by Messrs. H. & J. Groves in the 'Journal of Botany,' xxviii. (1890) p. 289.

"Only those who have come into close contact with the man or have carefully studied his works, can realize the greatness of the intellect of the veteran botanist who died at Penzance in July last. Had not his health and eyesight failed, there is little doubt that John Ralfs would have ranked as one of the greatest botanists of the century. His clearness of perception, his conciseness and exactitude of expression, added to his indomitable energy, his enthusiasm, and his wonderful memory, made him the very ideal of a naturalist.

He was born on Sept. 13th, 1807, at Millbrook, near Southampton. He came of an old Hampshire family, being the second son of Samuel Ralfs, of Mudeford, near Christchurch. His father died in 1808, and the young family was brought up by the mother, who disposed of the property at Mudeford, and removed to Southampton. Young Ralfs's first school appears to have been that of Dr. Buller in this town; he afterwards went to Mr. Jennings's at Bishop's Waltham, and subsequently to the Rev. J. Jenvey's at Romsey. To the last-named gentleman he became much attached, and to him he dedicated his first botanical book. As a lad Ralfs was studious and painstaking, and showed an early inclination to scientific pursuits which first developed in the direction of chemistry. At about the age of eighteen he was articled to his uncle, a surgeon at Brentford, with whom he remained two years and a half, after which he studied at Winchester Hospital for two years. In 1832 he passed the examination qualifying him as a surgeon, and in this examination we find that he distinguished himself by his knowledge of botany. He went into partnership with a surgeon in Shoreditch, and

* Ann. of Bot., iv. (1889) p. 163.

Mr. Marquand tells us that he practised at Towcester. During the few years that he was able to follow his profession he was very successful. While on a visit to Torquay he became acquainted with Miss Laura Cecilia Newman, daughter of Mr. Henry Newman, of London, and in 1835 was married to that lady. They had one son, John Henry, who was born in 1836. The marriage did not prove a happy one, for within two years Mrs. Ralfs (with her infant son) went to live with her parents, who were then residing in France; she afterwards travelled in Italy, but returned to France, where she died in 1848.

In 1837 Mr. Ralfs's health became so bad, his lungs being found to be seriously affected, that he was obliged to relinquish his practice and to reside in one of the health-resorts on the south-western coast. After visiting Torquay, he settled down, in November 1837, at Penzance, which continued to be his home during the rest of his life. In 1838 he contributed the botanical portion of a guide to Ilfracombe by Banfield. In 1839 he published his first book, 'The British Phænogamous Plants and Ferns; arranged on the Linnæan System, and analysed after the method of Lamarck'; this consisted of a dichotomous key to the genera and species, with an analysis of the natural orders. It did not pretend to compete with the larger "Floras," but was intended as a guide to the quick determination of species; and the simple straightforward language employed, the judicious selection of practical characters, and the small compass of the book admirably adapted it to the purposes of a pocket manual. At the commencement of 1841, Mr. Ralfs opened a correspondence with the Rev. M. J. Berkeley, whom he had met some years previously; this resulted in a close friendship, and Ralfs and Berkeley appear to have constantly consulted one another on questions connected with the Algæ and Fungi. Berkeley's correspondence (preserved in the Botanical Department of the British Museum) contains some hundreds of letters from Ralfs, many of them consisting of four closely written quarto pages, and containing pen-and-ink drawings. Ralfs seemed then to have settled down to the study of the Desmids and Diatoms, but continued to give a general attention to Fungi and other plants.

The summers of 1841 and several subsequent years were spent in visits to Ilfracombe and various parts of Wales, his longest stay usually being at Dolgelly. In 1842 he was accompanied on his Welsh trip by Borrer. In this year Ralfs sent a description of *Desmidium compressum* (a new species) to Dr. Balfour for the Botanical Society of Edinburgh. In 1843–4–5 he contributed to the same Society a series of papers on the Desmids and Diatoms, and in one of them he mentioned that the total number of Desmids previously recorded in the British Floras was four—two *Desmidia* and two *Euastra*. These papers were published in the 'Annals of Natural History' and in the 'Transactions' of the Society. They contain figures and descriptions of a number of species of Diatoms, and over sixty Desmids, of which sixteen were new. In 1845 also appeared his paper, 'On the genera *Spirulina* and *Coleochæte*,' A. N. H., xvi. p. 308. . . .

In 1848, after several delays occasioned by illness, his great work was published, 'The British Desmidieæ,' probably the finest monograph

which has appeared of any group of British plants. The descriptions are complete and lucid, the synonymy is very carefully worked out, and the analyses are in Ralfs's characteristically terse style. Particular attention is given to the reproductive states of the plants, which had been previously observed in very few species. An appendix contains descriptions of the species not known to occur in Britain, and the small number of these is an evidence of the leading position Ralfs had taken up as an authority upon the group. In a few years he had raised the number of known British Desmids from four to 180. Mr. E. Jenner's beautiful drawings contributed much to the value of the work, for he was not only an excellent draughtsman, but a good botanist, and well acquainted with the Desmids. During the preparation of the works Ralfs had extensive correspondence with Brébisson, Kützing, Montagne, and other leading foreign algologists. Berkeley seems to have been of great assistance in many ways. . . .

In 1856 he undertook the arrangement of the Diatoms and Desmids for the fourth edition of Pritchard's 'Infusoria,' but, through repeated illnesses, was only able to complete the Diatomaceæ, and this contributed to the delay in the publication of the book, which did not appear until 1861. His work, however, was very thorough, and gave an account of the whole of the known Diatomaceæ, both recent and fossil.

The sudden failure of his eyesight about this time rendered future microscopical research impossible, thus putting a stop to the great work of his life, and he does not seem to have recovered from the shock for many years. He turned his attention more and more to working out the flora of West Cornwall. . . .

Mr. Ralfs bequeathed his collection of microscopic plants to the Botanical Department of the British Museum, but his will was not witnessed, and had consequently no legal force. His son has, however, in consideration of his father's wishes, generously resolved to place the collection in the British Museum."

That of Prof. Parker is an anonymous notice, clearly from the hand of one who knew him well, which appeared in the 'Times' of 7th July last.

"By the sudden death, on the 3rd inst., of Mr. William Kitchen Parker, F.R.S., formerly Hunterian Professor of Comparative Anatomy at the Royal College of Surgeons, science in this country has lost one of its unique investigators, a man of the order of Faraday, if lacking his great constructive powers. The son of a farmer in South Lincolnshire, his schooling was of a very limited character except for three-quarters of a year spent at Peterborough grammar school, after which he became an assistant to a chemist at Stamford. He had already been attracted to the mysteries of anatomy as they chanced to come under his notice in farming life, and with no instruction whatever he had made skeletons of many animals. While at the chemist's, engaged at business from 7 a.m. to 10 p.m., he rose several hours before his morning's work began, and with a fellow-apprentice scoured the neighbourhood for botanical specimens. Thus in two summers he formed and preserved a collection of 500 species of plants.

After a few years he came up to London as a surgeon's assistant

and, still continuing to make progress in anatomy, he became assistant to Professor Todd at King's College, and qualified for medical practice in 1849. He made during these years many beautiful injected preparations of organs, and also laid the foundation for his later microscopical work on the Foraminifera. Indeed, it was as a student of the latter minute organisms that he first came before the scientific public in 1857, when he began to publish, in conjunction with his friend Professor Rupert Jones, a long series of important papers in the 'Annals and Magazine of Natural History,' in which many significant facts as to their variability and polymorphism in parallel series were first brought forward.

A few years later, ill-health, the result of much unremunerative scientific work combined with a laborious medical practice, began to make serious inroads on Mr. Parker's physical strength, and he had to give up much of his professional work. In the intervals of the severest pain he accomplished some of his most striking researches, which were often taken up as an anodyne. Many valuable monographs, such as those on the skulls of the common fowl (1869), of the frog (1871), of the salmon (1873), of the pig (1874), were the result of his labours, and when in 1874 he was appointed one of the Hunterian Professors of Comparative Anatomy it was felt that the mantle of Professor Huxley had fallen on a worthy successor.

Professor Parker lectured at the College of Surgeons until 1884, giving in his own quaint and discursive way the results of successive years of work. He had already been President of the Royal Microscopical Society in 1871–2, and this honour was followed by the award of a Royal medal by the Royal Society, of which he was already a Fellow. When the Government grant of 4000*l.* came to be distributed by the Royal Society it was generally felt that there could be no more fitting recipient of a considerable grant than Mr. Parker, and this was continued for many years, being at last partially replaced by a Civil List pension. No man ever worked from a purer love of science and of the beauty of the Creator's handiwork, which he delighted to acknowledge. He had grown up when minute naked-eye dissection had not been displaced by microscopic section-cutting, and it was a marvel to see him handle embryonic skulls a third of an inch in length and patiently dissect them under a simple lens till he had revealed features characteristic of some very diverse creature in the scale of development, or of some ancient animal which combined in itself characters now split up among various extreme branches of the vertebrate kingdom.

Altogether he wrote more than twenty memoirs of first-class importance, illustrated by many hundred plates from his own careful drawings, and published by the Royal, Zoological, and Linnean Societies. Unfortunately they are a sealed book to all but skilled anatomists, for notwithstanding brilliant flashes and quaint conceits and illustrations, Mr. Parker's style of exposition by no means did justice to the value of his matter. One portion of his work was, however, summarized and brought out by him in 1877 with the aid of his friend, Mr. G. T. Bettany, under the title 'The Morphology of the Skull,' and another portion formed the subject of a volume, issued in 1885, on 'Mammalian Descent,' being the Hunterian lectures for 1884. But his friends will remember,

even more than his scientific labours, the charms of his ingenuous enthusiasm and the warmth of his scientific ardour. For many years a great sufferer, he had been much shaken by the recent death of his wife, but his health did not appear worse than usual when he suddenly expired at the house of his second son, Professor W. Newton Parker, of the South Wales University College, Cardiff, at the age of 67."

β. Technique.*

(1) Collecting Objects, including Culture Processes.

A Homely Zoophyte-trough.†—Dr. J. Anderson Smith remarks, "The constant trouble I had with the usual glass zoophyte-troughs, either from leakage, too great depth, or too large size, led me to try something else. And first I tried cork rings of various diameters and depths, but the difficulty of cutting evenly, and the occasional perforation in the cork allowing air-bubbles to get into the cell, soon caused me to abandon these. I now use indiarubber rings, which give me perfect satisfaction. I take an ordinary glass slide, find the centre, and then fix on to it by means of Canada balsam, an indiarubber ring, 5/8 in. diameter, 1/8 in. deep, and 1/8 in. thick. Rings of any required size or depth may be used. Filling the inclosed space with the water and weed to be examined until the surface of the water is slightly convex above the plane of the upper surface of the rings, I then place a cover-glass of the requisite size on the top, and the trough is ready for examination. Capillary cohesion holds the cover-slip perfectly tight, so that the trough may be turned upside down without spilling the contents.

The advantages I claim for this little trough are:—First, its cheapness; second, the facility and rapidity with which it can be made. Moreover, by choosing various sized rings, troughs of any depth and size can be made, and such a trough may be readily used at the pond-side for rapid examination of small portions of the material collected. Lastly, it is less cumbrous than the glass trough and more useful in my experience. The rings I have chiefly used are such as one gets from certain mineral water bottles; the dimensions given are those of a ring labelled "Matlock Mineral Water Co."

A New Collecting Net.‡—Mr. Charles S. Fellows has recently devised a collecting net for small organisms, consisting of a silk mull (or bolting cloth) funnel whose largest diameter is about 12 in., kept open by a stiff brass ring. It is 15 in. deep and tapers off to 3/4 in. at the smallest end. In this (the apex of the cone) is fixed a brass ferrule about 3/4 in. in diameter and 2 in. long, made with a shoulder on each end, one to prevent it from slipping off the net and the other to prevent a *silk bottle* from becoming detached.

This silk bottle can be made of any size, but is most convenient for use about 3/4 in. in diameter by 2 in. in height, and made of the

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Journ. of Microscopy and Nat. Sci., iii. (1890) pp. 254–5.

‡ The Microscope, x. (1890) pp. 247–8.

Fig. 91.

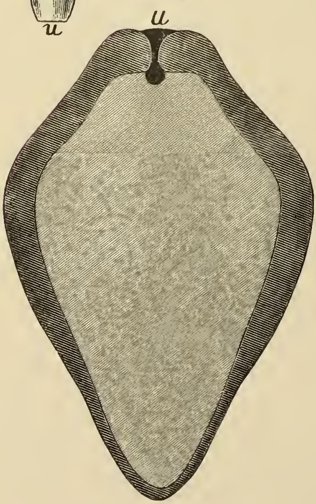
Fig. 92.

same kind of silk as the net. To use the apparatus, first tie the little silk bottle on the ferrule, then drag the net after a boat, or through the water from the shore, by tying it to the end of a fishing rod or walking-stick. As soon as the "catch" is in the little silk bottle it is untied from the ferrule, using the same string to tie up its mouth, and put into the alcohol bottle. Each silk bottle is numbered so that a record of time and locality can be kept. This is much superior to the use of a glass bottle, for in pouring out enough of the contents of the glass bottle in order to insert the cork, one often loses very interesting forms, especially the *Cladocera*, on account of the bubble of air which usually is in the shells and which causes them to float to the top.

A useful net is simply made from fine silk mull, 15 in. in diameter and 30 in. long."

Suction Capsule.*—The suction capsule, the invention of Mr. N. A. Cobb, is made from glass tubing, 2–5 mm. thick. The tubing is heated in a blow-pipe flame in two places and drawn out (fig. 91). One end is then broken off and heated until the aperture becomes minute. The other end is drawn out to the form shown at *t* (fig. 92). If after stopping *u*, fig. 92, with glue suction be made at *r*, while the tube at *t* is melted with a blow-pipe flame, the suction capsule results (fig. 93). The use of this little instrument is to hatch eggs of parasitic entozoa in the alimentary canal. The eggs are placed within the capsule, and when swallowed, the gastric juice dissolves the glue and hatches the eggs. The capsule is easily recovered at the other end of the alimentary canal.

Fig. 93.



Böhm, A., und A. Oppel.—**Taschenbuch der mikroskopischen Technik.** (Manual of microscopical technique.) München und Leipzig, 1890.

* Proc. Soc. Linn. N.S.W., v. (1890) pp. 163–7 (3 figs.).

(2) Preparing Objects.

Demonstrating the Cell-Granula.*—Herr R. Altmann recommends as fixative for tissues to be examined for the cell-granula a mixture of equal volumes of a 5 per cent. solution of bichromate of potash and 2 per cent. solution of osmic acid. After twenty-four hours the pieces, which are of course very small, are washed in running water for several hours; then alcohol (75, 90, 100 per cent.); paraffin imbedding, for which they are placed, after the spirit, in a mixture of three parts xylol and one part alcohol; then xylol, xylol-paraffin, lastly paraffin, with a melting-point of 58°–60°. The sections made with the "Support-Mikrotom" are from one to two μ thick, and are stuck on the slide with a thin layer of caoutchouc (caoutchouc dissolved in 25 vols. chloroform). This solution is poured on the slide, drained, and after evaporation of chloroform heated gently, the paraffin sections are then stuck on and brushed over with a mixture of gun-cotton in aceton and alcohol (2 grm. gun-cotton dissolved in 50 ccm. aceton; of this 5 ccm. are diluted with 20 ccm. alcohol).

Acid fuchsin is recommended for staining and picric acid for differentiating the granula. The former solution is made by dissolving 20 grm. acid fuchsin in 100 ccm. of a cold saturated aqueous solution of anilin; the latter is a mixture of 1 vol. saturated alcoholic solution of picric acid and 2 vols. water. The sections are stained by pouring the fuchsin solution on the slide and carefully heating; this done, it is washed and treated in a similar way with the picric acid solution; after which alcohol, xylol, and dammar.

Another fixation method, by which the staining is rendered more brilliant, though the sections are thicker and the preparations less permanent, is as follows:—A saturated solution of red oxide of mercury is made in 30 per cent. nitric acid. Immediately before use one vol. of the foregoing is mixed with three vols. water and one vol. 50 per cent. formic acid. In this solution the fresh pieces are placed for several hours, after which they are transferred to alcohol, and thereupon the paraffin procedure.

A quite novel method, but which for mechanical reasons is as yet difficult and imperfect, is introduced by the author. It consists in freezing fresh pieces of organs and then drying them in vacuo over sulphuric acid at a temperature of less than 20° C. By this means no alteration in volume occurs in the pieces, which differ from the recent condition merely in the absence of water. The next step is to saturate the pieces, still in vacuo, with paraffin.

Demonstrating the Elastic Fibres in the Skin.†—Sig. V. Mibelli stains the sections in a solution made as follows:—(1) safranin 0·59, warm H_2O (80°) 50; (2) safranin 0·59, alcohol (90°) 50. When cold these two solutions are mixed.

After having been immersed in the solution for thirty-six to forty-

* 'Die Elementarorganismen und ihre Beziehungen zu den Zellen,' Leipzig, 1890, 145 pp., 2 figs., and 21 pls. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 199–203.

† Monitore Zool. Ital., i. pp. 17–22. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 225–6.

eight hours they are transferred to hydrochloric and spirit (absolute alcohol 100 grm., HCl 10 drops). The acidulated spirit is constantly renewed, until the dye is no longer given off, when the sections are allowed to remain five to ten minutes longer, after which they are removed to absolute alcohol for twenty-four hours. Then bergamot oil and xylol dammar.

By the foregoing method the author claims that elastic fibres are well stained, but only if the solution be made in the manner prescribed.

Demonstrating the finer structural relation of the Liver.*—Herr A. Oppel applies Golgi's method to the liver as follows :—A small piece of rabbit's liver is treated with bichromate of potash quickly increased from two to five per cent. In three weeks' time the piece is placed in 3/4 per cent. nitrate of silver solution. In a few days the ultimate bile-ducts are stained.

The author gives the result of his procedure with monochromate of potash (0·5 per cent.) and silver nitrate on objects kept in spirit for a long time. Three per cent. solution of bichromate and 0·5 per cent. chromic acid were, however, found to show the biliary network quite as well.

Killing and hardening Pelagic Animals.†—Herr B. Friedlaender finds, from the experience of a few months, that the most efficacious fluid for killing sea animals (Siphonophora, &c.) is a mixture of water 1000, zinc sulphate 125, copper sulphate 125. The solution is placed in one vessel, and the animals in sea water in another of similar size. The contents of the former are simply poured into the latter vessel.

For hardening, a 1 per cent. solution of osmic acid in sea water is recommended, while for delicate objects osmic acid may be added or even used alone as a 1/5 per cent. solution.

Preserving lower Organisms in Microscopical Preparations.‡—Pure blood-serum is recommended by Dr. W. Migula as a suitable medium for examining and preserving delicate animal and vegetable objects. He uses the commercial blood-serum, and filters in an ice-box through bibulous paper frequently changed. The filtrate is mixed with 10 per cent. pure glycerin and incubated at 45° to 50° C. When all the water has been evaporated, the glycerized jelly is preserved in stoppered vessels. When required for use, a small quantity is dissolved in 10 to 15 times its volume of distilled water, and a large drop placed on the slide. Into this drop the living organism is pipetted and then the slide is placed in an incubator at about 50°, in order to thicken down the fluid. When of the right consistence, the cover-glass, moistened with a mixture consisting of 40 parts glycerin, 20 parts absolute alcohol, and 40 parts water, is imposed. The preparation is again heated for a couple of hours, and then ringed round.

Preparing Blood of Arthropoda and Mollusca.§—According to Sig. G. Cattaneo the methods usually adopted for examining the blood of

* Anat. Anzeig., v. (1890) pp. 143–5. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 222–3.

† Biol. Centralbl., x. (1890) pp. 483–91.

‡ Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 172–4.

§ Bollet. Scient. di Pavia, xi. (1889) pp. 3–29, 33–57 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 213–5.

mussels are imperfect, either because they are too slow, or they allow the blood to mix with water. He advises that the mussel should be well cleaned and dried, and without being opened its heart should be pierced with a needle. Some blood is then collected and examined at once under the Microscope, because after one minute obvious pathological changes take place in the corpuscle.

Control preparations are made of blood preserved with osmic acid or palladium chloride (1 per cent.) and obtained either by the direct action of the reagents, or by injecting the animal in the organ of Bojanus with 1/2 to 1 ccm., using a Pravaz syringe. Other reagents mentioned do not appear to have given satisfactory results.

When examining the blood of Arthropoda, rapidity is still more urgent, since degeneration begins to set in in 10 seconds. From *Palæmon* blood is best obtained by perforating the posterior third of the body, in spiders by an incision in the thorax, from Libellulidæ larvæ by cutting off the head, and from insects by tearing off a wing. One device mentioned is to drop the blood or dab the organ exuding blood in a small drop of the fixative fluid previously placed ready on the cover-glass.

Blood of Arthropoda should be treated in a manner similar to that used for Mollusca, i.e. with one per cent. osmic acid or palladium chloride. If 3 per cent. acetic acid be used at once, it will fix the amœboid forms, but if the addition be delayed until the first or second stage of degeneration, these appearances are lost.

Preparation of Sections of Ammocœtes.*—Dr. W. H. Gaskell mainly relied on serial sections, the whole head having been imbedded in paraffin, or the brain was dissected out and then imbedded. 1 per cent. osmic acid, Perenyi's fluid with alcohol afterwards, with subsequent staining in boro-picro-carminate or picro-carmine and eosin were used; for staining on the slide anilin colours and hæmatoxylin were used. The sections were mounted in order; when they were so large that they were apt to be crumpled, the folding was got over by simply floating the series of sections on the surface of warm water and then transferring them to a slide previously coated over with albumen and glycerin.

Arrangement of Pigment in Eye of Arthropods.†—Mdlle. M. Stefanowska, in studying the arrangement of pigment in the eyes of Arthropods exposed to varying quantities of light, decapitated the animals, and at once divided the head longitudinally. The pieces were placed in a 1 per cent. solution of osmic acid. The time required to fix the histological elements varies, and can only be determined by trial; on the whole, however, the time varies between one and four hours. The eyes were next placed in a 25 per cent. solution of oxalic acid with alcohol; they were then washed in 70 per cent. alcohol and put into absolute.

After inclusion in paraffin, sections were made with Schanze's microtome; these demanded much time and patience, as the sections break easily. The richness in pigment forms one of the great difficulties in preparing sections, which must, therefore, be very fine; those made were generally 1/100 mm. in thickness, and it was only with some of

* Quart. Journ. Micr. Sci., xxxi. (1890) p. 382.
† Rec. Zool. Suisse, v. (1890) pp. 155–9.

the Muscidæ that a thinness of 1/200 mm. was obtained. Staining with hæmatoxylin was found useful in bringing out the contours of some of the cells.

Preparing Intestinal Canal of Ephemeridæ.*—Herr Ad. Fritze recommends that Ephemeridæ be fixed in absolute alcohol, imbedded in paraffin, and the sections stained with hæmatoxylin and borax-carmine. The intestine of *Bætis* larvæ should be prepared in physiological salt solution, gradually hardened in alcohol, and stained with borax-carmine.

Examining Cypridæ.†—For examining in physiological salt solution, Herr C. G. Schwarz fixed the animals in 30 per cent. spirit, heated to 70°, and afterwards hardened them in alcohol, increased from 70 to 100 per cent. They were decalcified in concentrated picric acid in six hours at 54°, and then washed in boiled water and imbedded in paraffin. Hot sublimate, Flemming's mixture, and also a mixture of 2 per cent. osmic acid 1 part, 2 per cent. acetic acid 5 parts, distilled water 4 parts, gave good results. The sections, which were stuck on with glycerin-albumen, were stained with picro-carmine and hæmatoxylin, hæmatoxylin and eosin, borax-carmine, and acetic acid carmine.

Isolation of the chitinous framework and of the muscular fibrillæ of the organs known as the seminal pump was effected by maceration in Moleschott's potash-solution.

Preparing Lumbricus terrestris.‡—After killing the animal by gradually adding spirit or hot water, Herr G. Goehlich examines freshly prepared organs in 0·5 to 1 per cent. salt solution. If the seminal sacs be left for one day in spirit their contents coagulate, and can be removed as firm lumps. In order to make sections, the intestinal canal is cleaned of earth and sand by the animal being starved for two or three days; it is placed in a covered glass vessel containing water and its excrement carefully removed. Fixation in cold sublimate solution or in absolute alcohol. Staining with alcoholic carmine. Paraffin imbedding.

Preparing Cestoda.§—Very good preparations of Cestoda, says Dr. F. Zschokke, can be obtained by staining them for six to twelve hours in extremely dilute Kleinenberg's hæmatoxylin (then washing in water to which a drop of alum solution or acetic acid has been added), as well as by the use of alum or borax-carmine. Then dehydration; oil of cloves and balsam. For sections, after fixation in corrosive sublimate, Mayer's carmine is to be preferred. Paraffin imbedding.

The marine Cestoda can be kept alive for twelve to twenty-fours in a mixture of sea-water and the intestinal mucus of their host.

Investigation of Development of Fresh-water Sponge.||—In his study of the development of the freshwater Sponge, Dr. O. Maas put large cover-glasses to float on the surface of the water of the aquarium

* Ber. d. Naturf. Gesellsch. zu Freiburg, iv. (1889) pp. 59–82 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) p. 212.

† Ber. d. Naturf. Gesellsch. zu Freiburg, iii. (1888) pp. 133–58 (2 pls.).

‡ Zool. Beitr. (Schneider), ii. (1888) pp. 133-67 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 209–10.

§ Mém. de l'Inst. Nat. Genevois, xvii. (1888) p. 396 (8 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) p. 209.

|| Zeitschr. f. Wiss. Zool., l. (1890) pp. 530–1.

in which the Sponge was developing. Numerous larvæ attached themselves to these, which could be easily taken out of the water and examined. With the aid of silver nitrate they formed excellent permanent preparations, which may be set up between two cover-glasses in Canada balsam. The sponges were hardened by absolute alcohol; for the larvæ the best preparation was found to be chrom-osmic-acetic acid. Borax-carmine and hæmatoxylin were the staining reagents. The anilin colours, Lyons blue and malachite green, were the best for staining sections in which it was desired to differentiate the yolk. Imbedding was effected with paraffin; when the larvæ had attached themselves to *Elodea*-leaves this was quite easy, but when free they must first be fixed to a bit of liver by albumen, on account of their very small size —scarcely larger than a large Infusorian. Very high magnification is necessary to make out the component cells.

Preparing Fungus-spores.*—Herr P. Hennings recommends a modification of Herpell's plan † for fixing and preserving the spores of fungi. The discoloration of white spores which frequently takes place when this method is employed, can be prevented by saturating with alcohol. Coloured spores can be best preserved by making the paper absorb from below a solution of colophone in alcohol.

Study of Saprolegniaceæ.‡—Prof. M. Hartog recommends the following processes for fixing and staining this family of fungi. The reagent used for fixing is a saturated solution of corrosive sublimate; the preparation is then washed with water and placed in absolute alcohol. The best staining reagent is a solution of the Naples boracic carmine, and the excess of colour is removed by an alcoholic solution of crystallized acetic acid. The staining succeeds best after the objects have been slightly acted on by a very slightly acidulated alcoholic solution of nigrosine, and is completed by a second more complete staining with nigrosine. The preparation may be mounted either in a solution of equal parts of sulphophenate of zinc and glycerin; in Canada balsam, after placing in absolute alcohol, to which is added, drop by drop, phenicated xylol in the proportion of 3 parts of xylol to one of phenic acid; or in essence of sandal-wood oil.

Preparation of the Lower Algæ.§—For cultures of the lower Algæ, *Chlamydococcus*, *Eudorina*, *Gonium*, &c., M. P. A. Dangeard uses Van Tieghem's moist chamber, consisting of a ring of glass fixed to the slide, and covered by a cover-glass, on the lower face of which is a drop of water containing the objects to be cultivated. The chambers are kept in a constantly moist atmosphere. The fixation may be effected by concentrated picric acid, 1 per cent. chromic acid, absolute alcohol, or 1 per cent. osmic acid. For studying the vibratile cilia or flagels, chromo-osmic acid is best employed, which admits of an immediate observation, or the object may be fixed on the slide by concentrated osmic acid; it is then covered by a cover-glass and stained by a trace of methyl-green or by hæmatoxylin. To study the internal structure it

* Verhandl. Bot. Vereins Brandenburg, xxx. (1889) pp. 136–7.

† Cf. this Journal, 1882, p. 122.

‡ Bull. Soc. Bot. France, xxxvi. (1889), Actes du Congrès de Bot., pp. ccviii.–ccix.

§ Notarisia, v. (1890) pp. 1001–6 (16 figs.).

is often advisable to fix with absolute alcohol for 24 hours, and stain with picro-carmine or aqueous hæmatoxylin. For spores or cells, the walls of which are not penetrated by these reagents, Tschirch's borated carmine may be used. When coloured to the right extent, the preparations should be studied in glycerin, Canada balsam, or essence of clove, after dehydrating by alcohol of about 80 per cent.

Preparing Sections with Elder-pith.*—Herr J. W. C. Goethart recommends the following method, where very thin sections are not required. A vertical slit is made in a cylindrical piece of pith, the pith being left much longer on one side of the slit than on the other, and the longer side is thoroughly soaked with alcohol. The object of which sections are to be made is then placed in the slit, and a thin platinum wire firmly bound round the whole. The whole is now moistened with alcohol, and placed in the microtome. The sections are then placed and examined in glycerin.

Mounting Algæ and Fungi.†—From practical experience, Mr. J. E. Humphrey strongly recommends, in the preparation of slides of Algæ and Fungi, the discarding of all fluids and cements, and the use of glycerin-jelly as recommended by Dr. L. Klein,‡ which he finds applicable to all classes of Thallophytes, after hardening with osmic acid. Even the colour of the pigments is, in most cases, perfectly preserved by this process.

The Preparation of Vegetable Tissues for Sectioning on the Microtome.§—Mr. A. J. M'Clatchie says, "Vegetable tissues vary so much as to the amount of protoplasm, cellulose, and other substances contained, that the methods used for obtaining good sections from them must vary greatly. I have prepared and sectioned fungi, lichens, the cotyledons, plumules, hypocotyledonary stems, roots, root-tips of the cucumber, young pine-cones, young wheat-blades, lilac-buds, and bean-stems, with varying degrees of success.

Lichens and the young firm cotyledons of the cucumber could be dehydrated, and permeated with paraffin much more rapidly than young meristemic tissue, or tissue composed largely of cellulose and water. The former may be placed in 50 per cent., 75 per cent., 90 per cent., and 100 per cent. alcohol, chloroform, chloroform and paraffin, and finally in paraffin at a temperature of 55° C., remaining in each from two to twelve hours, and good results will be obtained. But the meristemic and the thin-walled watery tissue must be treated differently, or the tissue will come through very much shrunken and distorted, worthless biologically.

I have had the most success following the method described by Dr. J. W. Moll, in the 'Botanical Gazette' for January 1888. I have obtained good sections from all the material that I have treated in this way. I used a 1 per cent. solution of chromic acid and 20 per cent., 35 per cent., 50 per cent., 75 per cent., and 90 per cent. alcohols for

* Bot. Ztg., xlviii. (1890) p. 354 (1 fig.).
† Bot. Gazette (Crawfordsville), xv. (1890) pp. 168–71.
‡ Cf. this Journal, 1889, p. 140.
§ Amer. Mon. Micr. Journ., xi. (1890) pp. 190–1. From Amer. Naturalist, July 1890.

dehydrating. The chromic acid seems to fix the protoplasm, and macerate the cellulose, allowing the alcohols to pass more freely. I allowed the specimens to remain in the several per cents. of alcohol from two to twenty-four hours, according to their size and texture. As a rule, I found that the more gradually the specimens were dehydrated the better. From absolute alcohol, the specimens were placed in a solution of equal parts turpentine and paraffin. The solution containing the specimens was then raised gradually from a temperature of 20° C. to about 45° C. They were then placed in melted paraffin, kept as nearly at 50° C. as possible. Small specimens will be permeated in one or two hours, but large specimens require from four to six hours.

From the 75 per cent. alcohol I placed the specimens in a stain. The stains I tried were alum-cochineal, hæmatoxylin, fuchsin, methyl-green, methyl-blue, methyl-violet, and ammonia-carmine. I found alum-cochineal a good stain for fungi, plumules, stems, roots, and root-tips, but it would not penetrate the cucumber cotyledons. Fuchsin would penetrate anything I tried; but as it is soluble in alcohol, it is necessary to overstain the specimens, and then allow the colouring to come out until it is about right. Hæmatoxylin stained all the tissue that I tried except the young cucumber cotyledons. This stain gives large specimens a dark blue colour on the outside, and a purplish-pink colour on the interior. The nuclei and the cell-walls are brought out clearly. I did not have good success with the methyl colours, as they were easily dissolved out by the alcohol.

If specimens have not taken sufficient colour, or if the alcohol has removed too much of the colour, sections can be stained upon the slide, after they are cut. Any stain can be used, but none that I tried differentiated the parts sufficiently. Fuchsin will give enough colour in a few seconds. The sections must stand in hæmatoxylin from two to ten minutes, and in alum-cochineal from ten to twenty minutes. If it is intended to stain upon the slide, an alum fixative will be found better than collodion.

I heated the slides in the gas-flame to melt the paraffin, and poured on turpentine to wash it out. The specimens were then mounted in balsam dissolved in chloroform. Air-bubbles that appear when sections are first mounted, will disappear after the slides stand a few hours. If the razor or knife used for cutting is very sharp, small specimens may be cut 1/2500 or even 1/5000 in. in thickness. But larger specimens cannot be cut more than 1/600 to 1/1500 in. thick without crowding the tissues together and giving them the appearance of being shrunken."

Preparing, Preserving, and Mounting Objects of Natural History for the Microscope.*—Mr. N. Pike says his own method of procedure in selecting, preparing, and preserving small delicate specimens (excepting eggs) is as follows:—

"I first procure the most perfect live specimens and drop them in strong alcohol, and let them remain about twenty-four hours. This not only instantly destroys life without injuring the objects, but also hardens them a little. They are then taken from the alcohol and placed in small narrow tubes, which I have for this purpose, just large

* The Microscope, x. (1890) pp. 266-8.

enough to receive them, and are then covered with the following solution:—Chloral, in crystals, 1 oz., dissolve in 5 oz. of distilled water; alcohol, $1\frac{1}{2}$ oz.; glycerin, $1\frac{1}{2}$ dr.; rock salt, 15 gr.; saltpetre, 30 gr. Dilute the glycerin, salt, and saltpetre in the alcohol, and when well mixed add to the chloral solution. Shake well till thoroughly incorporated, filter, and it is ready for use. The liquid, if properly and carefully made should be bright and sparkling. Larvæ, spiders, &c., when prepared according to the above formula, are really beautiful objects, and can be examined with a low power of the Microscope. If wanted for dissection, they can be removed from the tube and be returned to it without any difficulty. I have thousands of specimens of soft-bodied animals now preserved in this solution, as fresh as the day I collected them.

If the objects are required for immediate anatomical examination they can be preserved for an indefinite time, and brought to the dissecting table as fresh and flaccid as possible, by omitting the alcoholic bath.

I have always by me a jar filled with the above-mentioned fluid, in which I place specimens I intend for dissection and minute microscopical examination. This jar is always very carefully corked, as the preparation deteriorates when allowed to evaporate.

The preserving of small objects in these tubes of pure white flint glass is far preferable to the building of glass cells, which are often leaky and easily get out of order. When very small objects are required I make a slight difference in the solution, but only long practice can give the precise methods for each article, as different specimens require different manipulation.

Goadby's solution makes fine preparations, but in time the corrosive sublimate in it produces white deposit on the specimen and spoils it. All solutions containing much glycerin are apt to affect calcareous substances when present.

Among many of the freshwater and marine Algæ I have succeeded in preserving specimens, to my perfect satisfaction, in the following solution:—Distilled water, 1 oz.; rock salt, 2 gr.; alum, calcined, 1 gr.; carbolic acid, 1 drop.

Some specimens of Algæ, now twelve years in this solution, are as fresh and bright as when first prepared.

Chloride of zinc solution is very useful, and has proved satisfactory in the preservation of animal tissues; it must be made of varying strengths, according to the softness of the parts to be preserved. It is recommended to use twenty to twenty-five grains of the fused chloride to one ounce of distilled water, and ten drops of phenic acid added to it. This is a capital solution for the larvæ of insects, and if stored in an air-tight tube or cell, will keep perfectly for years without deterioration."

BACHMANN, O.—**Leitfaden zur Anfertigung mikroskopischer Dauerpräparate.** (Instructions for making permanent microscopic preparations.)
München und Leipzig, 1890.

LOEWENTHAL, N.—**Zur Frage über die Anwendung von Terpentinöl in der histologischen Technik.** (On the use of turpentine-oil in histological work.)
Centralbl. f. Physiol., XXV. (1889) 2 pp.

(3) Cutting, including Imbedding and Microtomes.

Improvement in Thoma's Sliding Microtome.*—Prof. R. Thoma has recently made an improvement in his microtome (fig. 94) whereby the

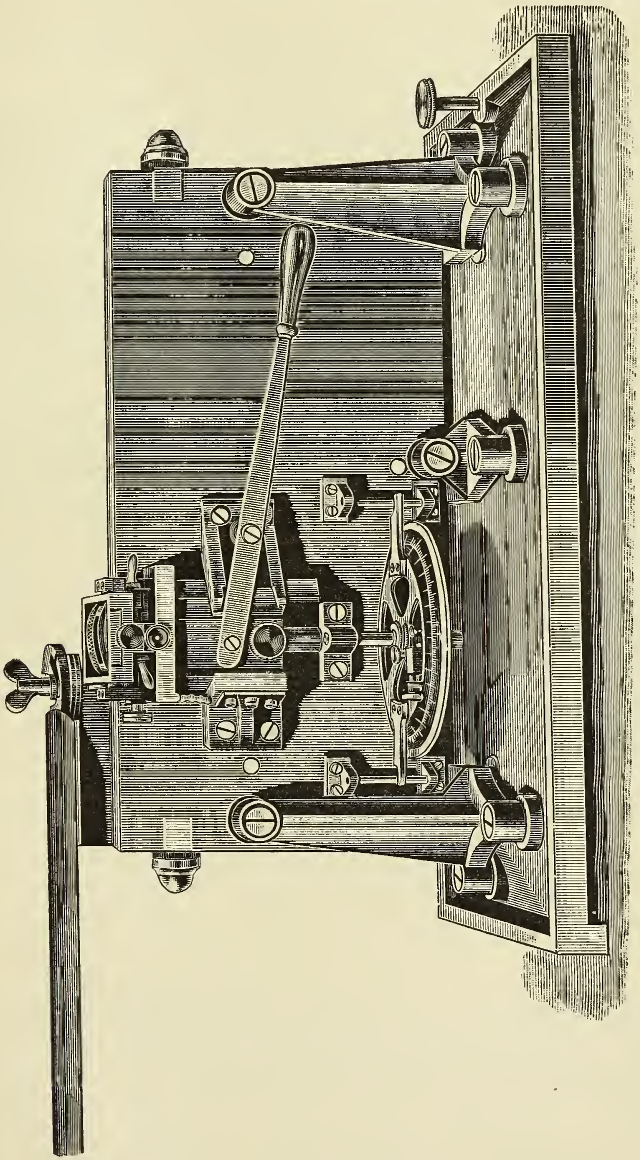


FIG. 94.

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 161–4 (1 fig.).

advantages derived from the slides resting on five supports are still secured. Under previous constructions it was impossible to cut an object more than 1 cm. high without moving either the knife or the preparation. The new arrangement allows continuous sections to be made from objects 3 cm. high. The object slide is now vertical, and the holder movable about two horizontal axes. In consequence of all these changes the instrument is considerably larger and heavier.

Apparatus for preparing Sections of Crystals cut in definite directions.*—Dr. E. A. Wülfing gives a description of this apparatus. It consists of three entirely separate parts:—(1) a "grinding tripod," with adjustable screw-feet and a carrier for the crystal; (2) a "levelling tripod," with micrometer screw-feet; (3) a levelled glass plate.

(1) Grinding tripod.—A brass plate *a* (figs. 95 and 96), 2/5 in. thick, and in the form of an equilateral triangle of 4 in. side, is provided at each corner with an adjustable steel screw *b*. These screws have square heads, on which the key E fits, and they permit of the plate being inclined about 15° in any direction. In the centre of the plate is a tube

Fig. 95.

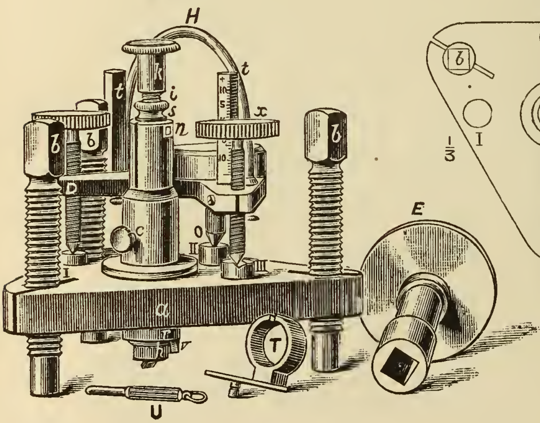


Fig. 96.

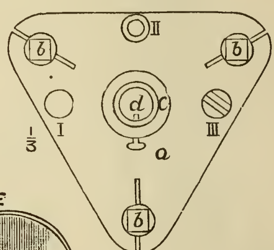


Fig. 97.

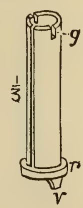


Fig. 98.

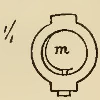


Fig. 99.

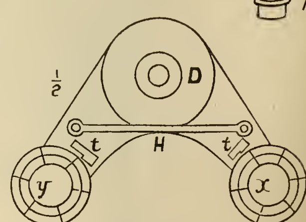


Fig. 100.

c, provided with a lug *d* (fig. 96) internally, which fits into a corresponding groove in a steel cylinder capable of free motion up and down, but not of rotation on its axis. The steel cylinder (fig. 97) is flanged at *r*, and the flange bears a projection *v*, the object of which will appear subsequently. The cylinder bears two lateral slots *g*, and its internal cavity is slightly conical. The brass cone (fig. 98) fits inside it, and is furnished at *h* with a flange and a broad disc-like base, whilst at top it bears a

* Zeitschr. f. Krystallographie, xvii. (1890) pp. 445–59.

screw-thread i with a nut s above, which is filed square to receive the detachable milled head k. The base of this brass cone serves as face for attachment of crystal, and the cone can be rotated within the cylinder and clamped firmly to it when in any position. In order to prevent the cone from rotating whilst it is being clamped by the nut s, a steel ring m (fig. 99) is firmly attached to the cone just below the screw-thread by tightening the small set-screw n. This steel ring has two lateral lugs, which fit into the slots g before mentioned of the steel cylinder, and thus prevent the cone from rotating. The brass plate a (fig. 96) bears three small circular steel discs I, II, III in the figure, which are destined to receive the feet of the levelling tripod, and are so arranged as to occupy the angles of an isosceles triangle right-angled at II.

(2) Levelling tripod.—A circular spirit-level D (fig. 100) is provided with two arms, each of which is bored and threaded at one end to receive a micrometer-screw x and y respectively. Immediately beneath the centre of the spirit-level is a third but non-adjustable leg, seen in fig. 95 above disc II. The legs occupy the angles of an isosceles triangle right-angled at II as before described. On turning the screws x or y the level is inclined about the point o, i. e. the extremity of the middle leg of the levelling tripod. The amount of inclination δ in each "screw-plane," i. e. the plane passing through o (above II) and either of the screw-axes, can be found if the pitch of the screw (h), the distance of the screw from the centre of rotation (λ), and the number of rotations (n) are known, for

$$\tan \delta = \frac{n.h}{\lambda}.$$

For practical reasons the inclination in the screw-plane is not measured in degrees on a divided circle, but by means of the tangent of the angle expressed in the number of rotations of a screw. For small angles, the angle and its tangent are interchangeable, e. g. if

$$n \text{ rotations} = 1^\circ\ 0'\cdot 0,$$

then

$$5\,n = 4^\circ\ 59'\cdot 3$$
$$10\,n = 9^\circ\ 54'\cdot 1.$$

The distance of the screws from the centre of rotation of the tripod and the pitch of the screws are so arranged that one rotation of the screw corresponds approximately to 1° of inclination in the screw plane. Each screw bears a divided head, permitting of 1/12° being read off and a single minute being estimated, whilst complete degrees (rotations) are indicated by the vertical scale t.

(3) Levelled glass plate.—This consists simply of a plate of mirror plate-glass, 6–8 in. square, supported on the top of a wooden bracket firmly fixed to the wall. Three brass screws with milled heads support the plate, and in conjunction with the spirit-level permit of its being accurately levelled.

(4) Method of preparing the apparatus for use.—The use of the discs I, II, III (fig. 95) is to permit the levelling tripod to be brought into a perfectly definite position on the top of the grinding tripod without

permanently connecting the two. During the grinding process the levelling tripod is lifted off by means of the handle H and put on one side to save it from damage or derangement. Before using the apparatus the three legs of the levelling tripod are brought to the same length by turning the screws x and y down to the zero of the scale t. The levelling tripod is placed in position on the top of the grinding tripod, and the two combined on the top of the levelled glass plate. The bubble of the spirit-level is brought to its central position by turning the screws b of the grinding tripod, and then the levelling tripod is laid aside. A small flat face F (not shown) is then ground (with emery and water on a glass plate) on the projection v of the steel cylinder, the brass cone being laid aside. After ascertaining that the three screws b have worn equally during the grinding, which is shown by the bubble being still in the centre when the two tripods combined are again tested on the levelled glass plate, the face F is polished. The screw x of the levelling tripod is next to be brought to one of its extreme positions, e. g. $+12°$ on the scale t, the bubble is again brought to its central position by means of the screws b, the levelling tripod is lifted off, and a second face f' is ground on the projection v. Similarly, after turning the screw x to its other extreme position at $-12°$, a third face f'' is ground. These three faces must lie in a zone, if the apparatus acts properly, and their angles will be very nearly twice 12°.

(5) Theory.—Assuming that we know the position of two faces A and B of a crystal, it is required that a new face C shall be ground which shall make with A and B the angles b and a. The face F ground on the projection v of the steel cylinder serves for orientation.

For the orientation of the crystal with regard to the plate on which it is to be ground, we require to determine the inclination of A and B to the steel face F, for this latter face is parallel to the glass grinding plate when the levelling-tripod screws stand at zero. In order to arrive at the desired face C from the face F the crystal must be so inclined that in its new position the grinding plate comes to lie at the same angle to the faces A and B as that at which C is required to lie, or, in other words, that C takes the place previously occupied by F.

The crystal is cemented in approximately the required position, judged by eye or with the aid of a hand-goniometer, to the base of the brass cone (fig. 98) at h. The brass cone is then rotated within the steel cylinder until one of the known faces, e. g. A, falls in the zone of the steel faces f' F f'' [not figured]. After this adjustment has been made, and A thus brought to a position at right angles to the screw-plane passing through the screw x, the angles a' and b' which B and A make with F are measured on a goniometer. The corrections necessary to be made in the position of the crystal are then calculated. For the details of the method of calculation we must refer our readers to the original paper. Our means of correcting the position of the crystal depend on our being able to incline it in two planes at right angles to one another, which we may assume to be the screw-planes of the levelling tripod. We carry out these corrections by turning the micrometer-screws in the reverse direction to that which would be required if the crystal occupied the position of the spirit-level. We then place the so adjusted levelling tripod again on the top of the grinding tripod—which latter we assume

to be still perfectly level—and bring the bubble of the spirit-level to its central position by turning the screws *b*. We have thus brought the crystal into the required position for grinding the face C, which, laying the levelling tripod aside, we proceed to do.

The adjustment of the face A in the zone of the faces f' F f'' is made on a reflecting goniometer with a horizontal limbus, such as that of Websky-Fuess No. II. or III. A ring T (fig. 95) serves to hold the cylinder on the goniometer. Instead of depending upon calculation, the correction in the position of the crystal can be often sufficiently accurately made by two or three trials, a small surface being ground and polished, and its accuracy being tested on the goniometer without detaching the crystal from the brass cone or the latter from the cylinder.*

OBREGIA, AL.—**Serienschnitte mit Photoxylin oder Celloïdin.** (Serial sections with photoxylin or celloidin.) *Neurol. Centralbl.*, 1890, No. 10, 3 pp.

ROSS, J. F. W.—**Paraffin Method as used by Prof. Gaule, Zurich.** *Canad. Pract.*, XIV. (1889) p. 409.

(4) Staining and Injecting.

Staining with Chloride of Gold.†—Prof. A. S. Underwood writes:—"I have long regarded this agent as one of the most useful for the observation of the dental tissues. I know of no other stain which so clearly marks out the minute anatomy of the soft tissues which penetrate bone and dentine; in fact, its excellence as a selective stain would long ago have obtained for it a much more widespread popularity were it not for the fact that it has been generally regarded as specially liable to failure in manipulation. Almost all the recognized text-books speak of it as a very difficult stain to employ successfully, and as requiring a very lengthy and troublesome method of procedure, and as only applicable to perfectly fresh tissues. I have found, after some eight years of pretty constant use, that the subjoined method is easy to employ, does not take long, and is, moreover, both certain and fairly permanent in its results.

First, about the tissues to be stained. They do not require to be very recently dead; the fresher they are the more quickly they take the stain, but I have stained scores of sections of teeth and bone that had been severed from the living body for a long time, sometimes for weeks. It is better to avoid as far as possible the use of metal instruments, bone, wood, or quill being preferable; the use of steel does not, however, doom the staining to failure. The method I adopt is as follows:—

(*a*) Wash the sections in solution of bicarbonate of soda.

(*b*) Put some 1 per cent. solution of chloride of gold in a watch-glass, test it with litmus-paper, and if it be acid add bicarbonate of soda by drops till it is neutral; place the sections in the solution and cover the watch-glass with some lid to keep it in the dark (the lid of a china pot such as is used for potted meat serves very well) for from half an hour to an hour, until the sections look straw-coloured.

(*c*) Remove sections from staining fluid to distilled water, and leave

* We understand that this instrument is only to be obtained from Herr Zimmermann, Hauptstrasse, Heidelberg.

† Journ. Brit. Dental Assoc., xi. (1890) pp. 696–7.

them covered over (they must never be exposed to light for more than a few seconds) for a few minutes.

(*d*) Put some 1 per cent. formic acid in a watch-glass, float the glass in hot water, put the sections in the acid, cover them over, and keep them in the dark and fairly hot until they turn crimson. This generally takes about an hour, but the operator must be guided by the tint of the sections, which he must look at from time to time. A simple way to do this is to fill an old china anchovy paste-pot with hot water, place it on a stove, float the watch-glass containing the acid and the sections in it, and cover it up with its own lid.

(*e*) When stained, immerse the sections in cold distilled water for about half an hour.

(*f*) Dry sections and mount them in glycerin-jelly. Avoid Canada balsam. I have always found specimens mounted in Canada balsam go wrong. The bottle of gold chloride must always be carefully kept in the dark.

I have found this method very successful and very easy; moreover, I have many sections now in my possession which are quite eight years old and have not faded in the slightest degree."

Vital Reaction of Methylen-blue.*—Herr H. Kühn obtained specially purified methylen-blue for injecting into the dorsal lymph-sac of frogs. The reaction was obtained in about thirty-six hours by injecting every twelve hours one ccm. or three ccm. all at once of the strong solution.

When the animals were opened no effect was visible, but after five to ten minutes, all the organs, especially liver and kidneys, became blue from exposure to the air.

The preparations do not keep long, so they are useless as permanent microscopical preparations.

Influence of Colouring Matters on Spermatozoa.†—Dr. Emma Leclercq gives the following tabular statement as to the effects of various reagents on spermatozoa.

Colouring Matter.	Results.	
	On Nucleus.	On Accessory Corpuscle.
Carmine alone (Frenzel)	Light carmine	Pale rose
,, ,, (Flemming) .. .. -	Rose	Red
Renault's hæmatoxylin	Violet	Deep violet
Ranvier's picrocarmine	Rose	Orange
Ehrlich's violet and eosin	Violet	Rose
,, ,, and carmine	Violet	Rose
Picrocarmine and methyl-green	Violet	Carmine yellow
	(The spermatozoa being green)	

Preparing Nerves stained by the Vital Methylen-blue Method.‡—Herr B. Feist injects frogs with three or four ccm. of a strong solution

* Arch f. Anat. u. Entwickelungsgesch., 1890, pp. 113-5. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 230-1.

† Bull. Acad. Roy. Belg., lx. (1890) p. 138.

‡ Arch. f. Anat. u. Entwickelungsgesch., 1890, pp. 116-84 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 231-4.

of pure methylen-blue. The pigment is dissolved in physiological salt solution. The stain is fixed by means of the iodide and iodine solution or Hoyer's picrocarmine.

Such preparations are examined and mounted in glycerin. If, however, the pieces are imbedded, then platinum chloride must be used as fixative, since the picrocarmine and iodine are easily dissolved out by the various reagents used for imbedded specimens.

A still better method is to fix with picrocarmine for fifteen minutes, followed by one per cent. osmic acid for the same time, and then glycerin for some hours. The specimen can now be imbedded by the gum arabic method. This consists in taking a watchglassful of a solution of pure gum arabic having the consistence of thick syrup. To this are added six to ten drops of glycerin, and the whole stirred up with a glass rod. In this mixture the sections are placed and the whole left to dry until it has assumed a consistence suitable for cutting (about eight days). The imbedded object is then clamped in elder-pith and sectioned.

The chief objection to this method is that when the mass has acquired the proper consistence it must be cut at once, otherwise it becomes too hard.

New Method for Staining Sections of Central Nervous System.*—For staining sections of central nervous system, A. Breglia uses extracts of Campechy or Pernambuco wood. The former contains hæmatoxylin $C_{16}H_{14}O_5$, the latter brasilin $C_{22}H_{20}O_7$.

The extract is made as follows:—7 to 10 grm. of the wood in small pieces are soaked in 90 to 95 per cent. alcohol for five or six days. The mixture is then shaken up and the fluid is ready for immediate use.

Sections of nervous tissue hardened in Müller or Erlizki's fluid are placed for ten to fifteen minutes in 15 ccm. of 90 per cent. alcohol to which has been added three to seven ccm. of a saturated aqueous solution of neutral acetate of copper. The sections are next immersed for five to ten minutes in a saturated watery solution of lithium carbonate. They next come into ten ccm. of the extract for 18 to 24 hours. Decoloration is then effected with aq. dest. 100 grm., ferricyanide of potash 1 grm., borax 1 grm. When the grey and white matters have become differentiated to the naked eye, the sections are washed in distilled water, and then mounted in the usual way. For the Pernambuco wood extract, the method of manufacture and the manipulative procedure are the same, with the exception that the decolorizer acts very much more rapidly.

Staining Central Nervous Tissue with Palladium Chloride.*—Prof. G. Paladino recommends the chloride of palladium for staining sections of the central nervous system. The procedure is as follows:—To a 1 per thousand solution of chloride of palladium a few drops of hydrochloric acid are added in order to insure its complete dissolution. In this solution pieces of spinal cord 5 mm. thick are immersed. The cord has of course been previously hardened in bichromate salts, chromic acid, or in sublimate. In the palladium solution, of which a large quantity (150 to 200 ccm.) are used for each piece, the objects are

* Giorn. d. Assoz. dei Naturalisti e Medici di Napoli, i. (1889) pp. 169–72. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 236–7.

† Journ. de Micrographie, xiv. (1890) pp. 142–8.

left for two days, and are then transferred for twenty-four hours to a 1 per cent. solution of iodide of potassium. The pieces are next dehydrated in spirit from 80° to 96° successively, and when completely freed from water they are treated with chloroform and then imbedded in paraffin. The paraffin is removed from the sections with xylol, and these are then mounted in balsam.

This method, which is extremely simple, is applicable to peripheral as well as central nerves; the results obtained from it are extremely favourable. The hue imparted by the reaction of the iodide on the palladium is brownish, and allows the finer structural details, both of nerves and nerve-cells, to be easily seen.

Method for Staining Sections of Spinal Cord.*—Dr. R. Haug finds that the following method is simple and satisfactory for preparing and staining sections of spinal cord.

Fresh pieces of spinal cord of half to one cm. thick are immersed for two days in a saturated solution of neutral acetate of copper. After this they are placed for one to one and a half days in a five per cent. solution of bichromate of potash. After washing off the superficial deposit of chromic acid salt, the pieces are placed in the dark in 70 per cent. spirit for thirty-six to forty-eight hours, then for a similar period in absolute alcohol. They are now ready for imbedding in paraffin or celloidin. The paraffin having been removed, the sections are placed in the following solution (hæmatoxylin 1, in alcohol 30, plus ammonia-alum 1 in 300 H_2O), for fifteen to thirty minutes, or until they are of a deep black colour. After having been washed in water, the sections are toned down in muriatic acid 0·5 to 1·0, alcohol 70·0, H_2O 30·0. When sufficiently decolorized (fifteen minutes at most), the now red sections are washed for a long time in pure water until all the acid is removed and the colour is blue.

The sections may be contrast-stained by immersing them for a moment in undiluted neutral carmine solution, or in the following, which imparts a very pretty tone:—To 100 ccm. water, 0·25 carbonate of magnesia and 15–20 drops of liq. ammon. fort. are added. The mixture is heated, decanted off, and filtered. To the filtrate 0·59 carmine are added.

Should Weigert's method of differentiating be preferred, this may be effected by decolorizing the sections in the borax-ferricyanide of potash solution, and then proceeding in the usual manner.

The author claims for his method that it is not only not very complicated, but that it allows of a satisfactory examination of the cord in a comparatively short time.

Method for Staining the Gregarinæ of Molluscum contagiosum.†—Dr. R. Haug recommends the following procedure for demonstrating the Gregarinæ of Molluscum contagiosum. Fix for twenty-four hours in absolute alcohol, to which 1 per cent. of glacial acetic acid has been added. The specimen is then washed in running water for twelve hours; it is now hardened again in absolute alcohol (six to twelve hours), and then imbedded in paraffin. The sections are first stained with hæmatoxylin (hæmatox. 1 to 30 alcohol, added to ammonia-alum 1 to 300 H_2O). The sections are first over-stained and then differentiated with

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 153–5. † T. c., pp. 152-3 (1 pl.).

hydrochloric or oxalic acid alcohol. They are then placed in water for fifteen minutes. The sections are next momentarily immersed in ammonia-carmine solution, then in water, and lastly placed for ten to fifteen minutes in absolute alcohol, to which 2 per cent. of formic acid has been added. After this they are transferred to picric acid alcohol for fifteen minutes. Thus prepared the sections have a bluish-green hue; the gregarinæ are greenish, the cells blue, and the rest of the tissue rose-coloured.

Carmine Stains for Normal and Pathological Preparations.*— Dr. R. Haug prepares a double carmine stain for staining pieces *in toto* as follows:—2 grm. of carmine are rubbed up with 4 grm. of borax-carmine, and then boiled in a flask with 300 ccm. distilled water until the fluid is evaporated down to 280 ccm. After this, and when the solution has cooled down a little, from 10 to 15 ccm. of a 10 per cent. solution of acetic acid (glacial) are added by means of a pipette. The addition of the acid renders the solution transparent and of a bright red hue. Next day it is filtered and some crystals of thymol added. For staining *en masse* a piece of 0·5 cm. in width, two to four days is required. After this it is differentiated with hydrochloric acid alcohol (changed every half hour). This takes one to four hours. After this it is placed in a mixture of picric acid and alcohol for about twelve hours.

Ammonia-lithia-carmine.—This solution is made by dissolving 3 grm. carmine in 100 ccm. of cold saturated carbonate of lithia solution and then adding 5 ccm. of ammonia. It stains quickly and deeply. Wash in water and then differentiate in hydrochloric acid alcohol. Sections may be after-stained by immersing in picric acid alcohol.

In many cases when the specimen has been hardened in chromic acid, the following modification acts well:—1 to 1½ grm. carmine and 2 grm. bicarbonate of soda are boiled in 150 ccm. of water, and then 10 to 15 ccm. of a 5 per cent. glacial acetic acid added. When cold 5 ccm. lithium solution. The subsequent treatment as before.

(5) Mounting, including Slides, Preservative Fluids, &c.

A new Pressureless Mounting-clip.†—Mr. T. Pace writes: "I notice Mr. Bryan's note in the December number of 'Science-Gossip,'

FIG. 101.

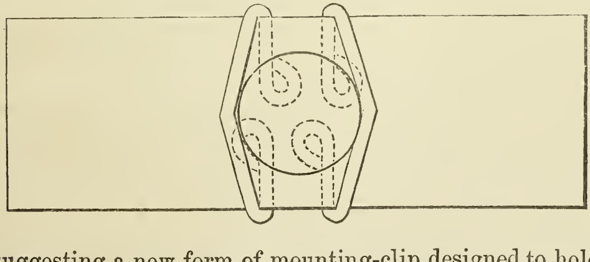
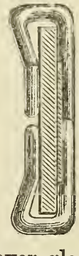


FIG. 102.



suggesting a new form of mounting-clip designed to hold the cover-glass without pressure, thus being a great improvement on the spring-clip

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 151–2.
† Science-Gossip, No. 303 (1890) p. 56.

commonly used; and as I have devised one which I think has some advantages over his, I inclose you a sketch of it, thinking it may interest some of your readers. Fig. 101 is an illustration of the clip in use as seen from above, and Fig. 102 is an end view of the same as seen from a section through the cover-glass. The clip should be made of rather stout springy wire, so as to grasp the slide firmly. This clip will be less liable to shift or become detached from the slide, and it has the advantage of being suitable for rectangular as well as circular cover-glasses."

Use of Gold Size.*—Mr. F. Disnett writes:—" Gold size as a foundation ring for coloured cements answers much better than shellac in mounting insects whole or in parts, or other materials where a thick layer of balsam is needed. Much trouble is caused in finishing with alcoholic cements, because the alcohol softens the thin crust of hardened balsam at the edge of the cover, air-bubbles appear, and the same often happens again in finishing with coloured cements. The colours will run in and spoil the mount. All this is avoided with gold size. Another advantage is that in the final cleaning the last trace of balsam on cover or slip can be washed off with alcohol. Gold size answers much better than arabin in protecting the ring for cleaning with alcohol, as the latter has no affinity for it, and arabin is well known to be one of the strongest cements we have. Before putting on the foundation ring, mounts should be carefully examined, to see whether the balsam extends to the edge of the cover. Small cavities often exist where an air-bubble has made its final exit. The cement will inclose the air, the thin film will collapse and leave the balsam unprotected. Gold size is slow in drying, but if one builds a number of cells to-day, they will be exactly a month old a month from now, and in time will get as hard as glass. Make them with one or two, seldom three, successive coats, and always aim to have a lot of old cells on hand. When I wish to mount in one I put on a light coat of fresh gold size, drop in the glycerin, and dissect whatever it may be in the cell. I use 3/4-in. cells mostly, and as I disentangle and separate different structures I push them aside, and keep on till I have material enough to fill the cell. I arrange what I have as well as possible, fill up with glycerin, and cover. Lots of handling and transferring are done away with."

Laboratory Notes.—Mr. A. F. Stanley Kent writes to us:—

(a) *Farrant's Medium.*—In making Farrant's medium for a large class it is desirable to modify the usual mode of procedure. The following method I have found satisfactory.

Make a solution with picked gum arabic to about the consistence of ordinary glycerin, mix it with an equal bulk of Price's glycerin and place it in an ordinary plaited filter, a few pieces of glass rod being placed in the funnel to keep the paper from lying too closely against the glass. Now close the mouth of the funnel by means of a glass plate on which vaseline has been smeared, place a flask under the funnel so as to fit the neck as closely as possible, and put the whole away for some weeks. A beautifully clear and bright solution will filter through into the flask.

* The Microscope, x. (1890) pp. 281–2.

I always add, before filtering, about 1/20 of a strong solution of thymol in absolute alcohol to the gum and glycerin (i.e. about one part of alcoholic solution of thymol to 20 parts of gum and glycerin solution). This, of course, precipitates some of the gum, but it soon becomes redissolved, and Farrant prepared in this way has kept sweet for many months.

The use of the glass plate is, first, to exclude dust, and secondly, and chiefly, to prevent evaporation.

(β) *Staining with Picrocarmine.*—In the histology courses at Oxford we use this stain very largely, as it is very convenient, easy to make, and preparations made with it are permanent. We stain the sections on the slide, remove some, *but not all*, of the stain with blotting-paper, and mount in Farrant; the surplus stain becomes mixed with the Farrant, but in a few days the section absorbs nearly the whole of it and as a result exhibits a better differentiation than can be obtained by any other means with which I am acquainted. I first saw the stain used in this manner by Professor Stirling, in the Owens College, Manchester.

(γ) *Connective Tissue.*—It is often difficult, in a class of histology, to demonstrate by means of the ordinary reagents the presence of connective tissue corpuscles in preparations of areolar tissue.

The following method has been found satisfactory:—Snip out a small piece of the subcutaneous connective tissue of a recently killed rabbit, spread it upon the slide by means of two needles *without the addition of any reagent*, then flood it with absolute alcohol for about one minute, remove alcohol, stain with hæmatoxylin, dehydrate, and mount in balsam.

Excellent preparations may also be made with methyl-green, but this reagent is not usually supplied to students in a class, requires special skill in its use, and is not permanent.

(δ) *Aspinall's Enamel.*—As a cement for ringing slides and making cells Aspinall's enamel has proved of great use. I have used it for some time and find that the white keeps well when used for balsam and Farrant mounts; but I have not used it for a sufficient length of time to know whether it possesses any advantages over zinc white cement.

The Differentiator.*—Mr. N. A. Cobb describes an improved form of the differentiator, or instrument for avoiding to the greatest possible extent those annoying and often destructive contractions which occur in delicate organisms while they are being killed and preserved. The instrument is made of glass tubing with an internal diameter of five or more mm.; two forms are shown in figs. 103 and 104. *a* or *a'* is the reservoir, *b* the object-box, and *c* the filter; these are three pieces of glass tubing joined by caoutchouc tubing. The filter is made by taking a piece of glass tube twice the required length, heating it red hot, drawing it out to arm's length, and breaking in two in the middle; the extremity should be drawn out very fine and a minute orifice alone left.

Taking an example of objects fixed by corrosive sublimate which are to be studied in balsam after staining with borax-carmine, the author directs us to proceed as follows. Fill the filter with perfectly clean sublimate

* Proc. Linn. Soc. N.S.W., v. (1890) pp. 157–63 (1 pl.).

solution, and insert a plug of cotton (boiled in water to remove the air) at the U-bend. Join the object-box to the filter, fill up with sublimate solution, and push a plug of cotton into the lower end of the box. Put the objects into the box, plug the upper end, and join the box and filter to the empty reservoir *a*. Now mix equal parts of sublimate solution and 33 per cent. alcohol (solution 2); mix equal parts of solution 2 and sublimate solution (solution 1). Mix equal parts of solution 2 and 33 per cent. alcohol (solution 3). Add solution 1 to the reservoir until it is one-fourth full, solution 2 till it is half full, solution 3 until it is three parts full, and fill up with 33 per cent. alcohol. If the solutions are carefully added the difference in specific gravity will prevent them mixing; if forced rapidly in, a nearly uniform mixture of about equal parts of sublimate and 33 per cent. alcohol will be formed. It is desirable to get an intermediate condition, when we shall have a uniform gradation or differentiation from sublimate solution to 33 per cent. alcohol in passing upwards through the reservoir. The objects should next be passed through borax-carmine, 50 per cent., 70 per cent., 90 per cent., and absolute alcohol; and finally to thin balsam. The differentiator should be used throughout the operation.

Objects which contract unexpectedly may be rendered insensible by the use of alcohol from 5 per cent. to 30 per cent., or through chloral hydrate, when they will be found insensible and outstretched.

Fig. 103.

Fig. 104.

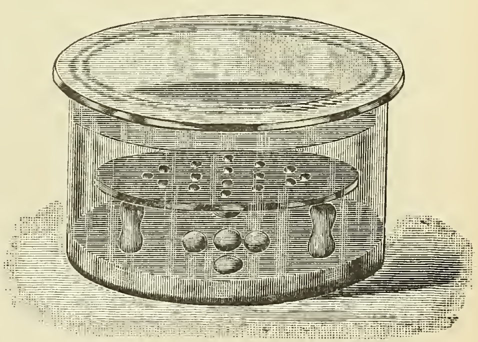
For further hints in manipulation, and a list of the mixtures used, we must refer to the author's detailed account.

How to clean old Slides and utilize spoiled Mounts.—Dr. H. M. Whelpley, in a paper read at the St. Louis Club of Microscopists, said, "For two years past I have permitted soiled slides and spoiled mounts to accumulate in a box set aside for that purpose. The process I have recently followed in reclaiming them has been successful. I first placed the unsightly rubbish in a dish of clean water, where it remained until all of the labels were readily removed. With an old knife I next scraped off the cells and all cement that could be easily removed in this manner. All slides where glycerin or other substance soluble in water had been used as a mounting medium were again washed, and then the entire pile spread out and dried. I separated those that were clean, and placed the rest in alcohol for several days. This solvent cleaned another

portion of the slides, so that all they required to render them as good as new was a washing in water. The remaining dirty ones were treated to a bath of oil of turpentine, where they rested for a few days. From this they were washed with alcohol, and then finished in water. The few refractory ones that held out during all this time were made as clean as ever with benzol. Although considerable time elapsed before the last slide was cleaned, it required but a few minutes of actual labour in the entire process. The time consumed is in letting them stand in the different liquids. Nor is the process expensive, as the oil of turpentine did most of the work. Hereafter I shall divide my old slides into three classes, and clean them separately, so that less alcohol will be required. The first box will contain slides that can be washed clean with water; the second lot will be those that alcohol will clean, and the third the ones requiring benzol. Cover-glasses are so cheap that I do not save them unless they are easily cleaned with water. I find it very difficult to properly clean thin cover-glasses that have cement on them."

Anilin Oil in Microscopical Technique.*—The brown colour of anilin oil, says Dr. Suchannek, the result of oxidation, is no bar to its use as a clarifying medium, or if intended for mixing with absolute alcohol. It is, however, of importance that it should be quite free from water, and it is advised that the oil should be distilled in the usual way and that the first 10–12 ccm. of distillate should be removed. The rest of the distillate should be received in a dry flask in which have been placed pieces of caustic potash. By this means the last traces of water will be effectually removed. The chief use of this medium is as a hydrant and clarifier, but it is also employed as a substitute for oil of cloves in paraffin imbedding.

Fig. 105.



The author describes a glass capsule (fig. 105) which he uses for dehydrating preparations in the anilin oil. In the capsule is placed a glass tray perforated with sixteen holes and supported on three legs. Underneath the tray are placed some pieces of caustic potash, and the anilin oil rises above the plate-level some millimetres. This device allows the preparations to be thoroughly dehydrated.

Piersol, G. A.—**Fixing Paraffin Sections to the Slide.**
Univ. Med. Magazine Philadelphia, II. (1889–90) p. 149.

Stirling.—**Dry Cover-glass Microscopical Preparations.**
Journ. of Anat., XXIV. (1890) p. 160.

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 156–9 (1 fig.).

(6) Miscellaneous.

Some Practical Business Applications of the Microscope.* —The man who has learned the use of the Microscope has certainly gained a great deal; but the man who claims to be a scientist without knowing the practical value of the Microscope, and without having learnt its use, ought not to be classed as such. The Microscope when first invented was considered as an accessory or a plaything. But since 1820, and later (1840), the first European oculists and scientists began to make microscopical researches, not only in the medical profession, but also in botanical, geological, and other studies. Since 1860 and 1870, the world over, the Microscope has been applied to almost every study and analysis. Had Galen, Celsus, and Hippocrates, and other ancients, had the use of the Microscope they would not have advocated the theory that the arteries in the human being contained air during life, instead of oxygenized blood. They were of the erroneous opinion that the blood simply acted as a humour in lubricating the tissues. Had it not been for the Microscope, James Paget, the great English surgeon and physician of St. Bartholomew's Hospital, in the year 1834, would not have discovered the *Trichina spiralis*, which had already slaughtered its thousands, dating as far back as the time of Moses.

The Microscope is certainly the greatest aid a scientific and a professional man can have. A physician without a Microscope is like a man without his hands: he is uncertain and unprotected. He cannot arrive at a correct and positive conclusion in diagnosing and prognosing his cases. It is important to have the Microscope at hand for examining the sputa of human beings, so as to be able to state positively whether or not the man is suffering with consumption (tuberculosis). It is important to be able to determine with certainty, at an early date, whether or not a man is suffering with cancer of the stomach by examining the vomits. A Microscope magnifying from 1 to 5000 diameters is a most simple piece of apparatus. Every person can learn its use in a few hours. Every person should learn to use a Microscope, not only the professional man and scientist, but every business man, even the grocer, butcher, farmer, and the housewife.

Everything that concerns a medical examination in a legal sense, or a legal examination in a medical sense, can be determined accurately by the use of the Microscope. For example, in the Cronin case of Chicago, where the medical experts demonstrated to a certainty that the blood, hair, and brain matter found in the Carlson cottage and sewer trap was that of a human body. Not only that, but they determined accurately and positively that the hair and blood found in the cottage and in the fatal trunk were that of Dr. Cronin, only in a modified condition; all with the aid of the Microscope.

Within the last decades scientists have demonstrated to a certainty the possibility of determining dried and old human blood-spots from that of animal blood, whether on clothing, wood, iron, or otherwise.

Pathologists and histologists have also demonstrated the great value of the Microscope in determining positively the skin, hair, blood, brain-matter, also the excretions and secretions of the human being from that of the lower animals.

* By Dr. F. Gaertner, Pittsburg, Pa., in Amer. Mon. Micr. Journ. See Engl. Mech., li. (1890) p. 483.

Again, the Microscope is applied in a medico-legal view, especially in malpractice, suits of damages, suits involving, rather than determining, the adulteration of foods and drink as to their purity, and finally, in determining whether or not food or drink has spoiled, undergone fermentation and the accumulation and development of micro-organisms, such as germs, microbes, and bacilli. Also, in the examination of oleomargarine and in the adulteration of drugs, liquors, milk, groceries, sausages, &c.

The application of the Microscope in a legal point of view is altogether new. We anticipate surprising effects from the application of the Microscope in the examination of legal documents, U.S. currency, and printed matter.

The following lines are from a very ample paper read by G. E. Fell, M.D., before the American Society of Microscopists, entitled "Examination of Legal Documents with the Microscope."

More than once has investigation with the Microscope cleared up the path of the attorney, ferreted out the work of the contract-falsifier, and shielded the innocent from the unjust accusations of interested rogues.

The range of observation in investigations of written documents with the Microscope is a broad one. We may begin with the characteristics of the paper upon which the writing is made, which may enable us to ascertain many facts of importance; for instance, a great similarity might indicate, with associated facts, that the documents were prepared at about the same time. A marked dissimilarity might also have an important bearing upon the case.

The differences in the paper may exist in the character of the fibres composing it, the finish of the surface, whether rough or smooth, the thickness, modifying the transmissibility of light, and the colour, all of which may be ascertained with the Microscope.

The ink used in the writing may be examined. If additions have been made to the document within a reasonable time of its execution, it is well to examine it microscopically with a great probability of detecting the differences of the original and additional inks. These differences may be present as follows: Some inks in drying assume a dull or shiny surface. If in sufficient quantity the surface may become cracked, presenting, when magnified, an appearance quite similar, but of a different colour, to that of the dried bottom of a clayey pond after the sun has baked it for a few days. The manner in which the ink is distributed upon the paper, whether it forms an even, somewhat regular border or spreads out to some extent, are factors which may also be noted. The colour of the ink, by transmitted or reflected illumination, is a very important factor. This, in one case, proved of great importance, and demonstrated the addition of certain words, which completely annulled the value of the document, involving several thousand dollars. And in a case where the lines of a document were written over with the idea of entirely covering the first written words, the different colours of the ink were revealed by the magnified image as seen under reasonably low powers of the Microscope.

Special attention is desired to the examination with the Microscope of written documents, United States currency, printed matter, &c., as to their genuineness from a legal standpoint. The principal feature in the examination of written and printed documents is in the erasures and the

additions, in the different colouring of different inks applied, and the mode of their execution.

Erasures can be accomplished either with a knife or by a chemical preparation. The former process is the one commonly resorted to, and is effected in the following manner: With a well-sharpened knife-blade the surface of the paper is carefully scraped until all objectionable lettering and wording is supposed by the naked eye to have disappeared. With a microscopical examination you can at once detect the impression made by the stroke of a pen. Even the different colours of the ink are still to be seen with the Microscope.

The second method being by a chemical preparation, the ink is made soluble and then easily removed from the paper by means of a blotter or absorbent cotton. This method is also an incomplete one, and the letters can easily be made out by close observation where a chemical preparation has been used for erasing. In most cases it leaves a stain, and the fibres of the paper are more or less injured by the chemicals used, always leaving evidence that the document has been tampered with.

Geo. E. Fell, in his paper, says the eye of the individual making the erasure is certainly not sufficient, and even with the aid of a hand magnifier the object might not be effectually accomplished. The detection of an erasure made by the knife is a very simple matter, and may be accomplished by the novice. An investigation may be made by simply holding the document before a strong light, and this is usually all that is necessary to demonstrate the existence of an erasure of any consequence. This is, however, a very different matter from making out the outlines of a word or detecting the general arrangement of the fibres of the paper, so as to be enabled to state whether writing has been executed on certain parts of the document. Again, when we enter into the minutiæ of the subject, we find that the compound Microscope will give us results not to be obtained by the simple hand magnifier.

On several occasions I have had the opportunity of demonstrating with the Microscope additions made to certain documents, two of which were wills. The additions were made in the following manner (which the Microscope revealed): First an erasure must have been produced, then there was a writing over the erasure. With the Microscope you could at once detect the erasures and the additions; also the different colours of the inks used, and, next, the most important characteristic of the microscopical examination being in the close observation of the stroke of the pen of the original lettering and the additional lettering, and, finally, the general mode of their execution.

In the examination of legal documents, U.S. currency, printed and mutilated documents, including forgeries, &c., involving a legal question and investigation, the principal features in the microscopical examination, as already stated, are the erasures, additions, colour of the ink, stroke of the pen in the original lettering and additional lettering, and, finally, the mode of their execution. This includes the general and comparative expression of the original writing—that is, in the observation of the letters constituting the document. Especial attention is needed in the observation of the shading, and in the general formation of the letters by the stroke of the pen, either in a downward or upward movement. This applies not only to the capital letters, but also to the

smaller letters, even to the punctuation, grammatical and orthographical relationship, and in comparative differentiation. All these things must be taken into consideration.

In the examination of papers, documents, such as wills, notes, cheques, &c., as to whether or not they were mutilated and forged, the Microscope will certainly be the most reliable test, much the easiest and simplest.

This is the way of determination, and an expert microscopist and observer can at once arrive at a correct and positive conclusion as to the genuineness of the autograph, &c.

In the examination of U.S. currency the same will hold good as in the examination of written and printed matter, with the exception that additional observation is necessary in order to differentiate a genuine bill from a counterfeit. This lies in the microscopical examination (1) of the quality of paper used; (2) in the execution and finish of the bill; (3) the grade and colour of the ink; (4) the printed condition of the bill, including the autograph; (5) the most important and characteristic means of determining a genuine bill from a counterfeit bill being in the observation of the red line which runs lengthwise across the bill, and it will be necessary to notice that the two red lines in a genuine bill are simply red silk thread interwoven in the paper of the bill, when in a counterfeit the red lines are simply red ink stripes, and no silk lines whatever.

Medico-Legal Microscopy.*—The thirteenth annual meeting of the American Society of Microscopists was opened with a discussion on the "Proposed Standing Committee on Medico-Legal Microscopy," by Prof. Ewell of Chicago. The professor began the discussion by declaring that the Microscope was by no means the simple instrument usually imagined. On the contrary, he stated that it was an exceedingly difficult instrument to handle. Some of the pointed stories about the Microscope are the strongest points in favour of a medico-legal committee, as this would have a tendency to stop the circulation of stories exaggerating the powers of the Microscope. He called attention to an article in a scientific paper, telling how the brain-matter found in a Chicago sewer was identified as coming from Dr. Cronin's head. No one had previously heard of Dr. Cronin's brain being exposed until the autopsy. This Dr. Ewell deprecated in the highest degree. To assume for the Microscope a position of infallibility, from a medical standpoint, is an absurdity, and goes a long way towards injuring the general standard of the profession.

Dr. Frank L. James, Prof. Seaman, Mr. H. L. Tolman, Dr. Stillson, and Prof. Claypole were in favour of such a committee to correct these wrongs. Newspapers have often spoken about the identification of blood by aid of the Microscope, but the best microscopists know that they cannot positively tell human blood. They can tell the difference between the blood of amphibians, mammalia, and fowls. They were of opinion that the committee would do a very great work if it could curb the enthusiasm of those who over-estimate the field of the Microscope. Courts should be given a standard by which the power of the Microscope can be judged.

* Amer. Mon. Micr. Journ., xi. (1890) p. 199.

When the discussion was finished, the President appointed Professors Ewell, Seaman, and Claypole, Mr. Tolman, and Dr. Stillson as a committee to map out the work of a standing committee on this branch of microscopy.

Millon's Reagent.*—Signor A. Poli calls attention to the unsatisfactory quality of this reagent as obtained from some of the leading manufacturers, its property of imparting a rose-colour to proteids being often only very feebly displayed. He believes this to arise from the fact that it is not a stable compound, and it should therefore always be prepared fresh by the operator himself. Millon's prescription for preparing the reagent is as follows:—Mercury is dissolved in an equal weight of nitric acid diluted by 4·5 equivalents of water. The solution is commenced in the cold, and finished by heating slightly until all the mercury is dissolved. Crystals are then formed, and the liquid is decanted and diluted with two volumes of water. The solution thus obtained contains mercurous nitrate $Hg_2(NO_3)_2$, mercuric nitrate $Hg(NO_3)_2$, and free nitric acid, and is thus a mercurous-mercuric nitrate. In consequence of the difficulty of obtaining nitric acid perfectly free from water, Signor Poli prefers Poulsen's method, as follows:—10 grm. of mercury are dissolved in 25 grm. of nitric acid of sp. gr. 1·185, heating not above 50° C.; this solution is then mixed with another obtained by dissolving 10 grm. of mercury in 22 grm. of nitric acid of sp. gr. 1·25–1·30; the reagent should be prepared and employed as much as possible in the cold.

Tests for Mineral Acids and Mineral Bases in Plants.†—Herr A. F. W. Schimper recommends the following microchemical tests for detecting the presence of mineral acids and mineral bases in the ash of plants:—

Lime.—The production of crystals of calcium sulphate by addition of sulphuric acid; also, in certain cases, the formation of crystals of calcium oxalate by addition of ammonium oxalate, or of calcium carbonate by ammonium carbonate.

Chlorine.—Precipitation by silver nitrate or thallium sulphate. Where present in large quantities, potassium or sodium chloride may be crystallized out of an aqueous solution of the ash.

Potassium.—The production of potassium-platinum chloride, insoluble in water and alcohol.

Magnesium.—The formation of ammonium-magnesium phosphate by addition of sodium phosphate or sodium-ammonium phosphate with the addition of ammonia. The formation of magnesium-sodium uranate, by the use of uranacetyl.

Sodium.—The same as the last.

Oxalic Acid.—Formation of calcium oxalate.

Phosphoric Acid.—The production of ammonium-phospho-molybdate by the addition of ammonium molybdate and nitric acid. Formation of magnesium-ammonium phosphate.

Nitric Acid.—Formation of an anilin-blue with diphenylamin. An extraordinarily delicate reaction. Production of calcium nitrate.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 446–50.
† Flora, lxxiii. (1890) pp. 210–20.

Sulphuric Acid.—One of the most difficult determinations, as the occurrence of a precipitate with barium chloride by no means proves the presence of sulphuric acid. Crystals of potassium sulphate may be obtained from a solution of the ash.

Tartaric Acid.—May be precipitated by potassium acetate or calcium chloride.

Behaviour of Fossil Teeth to Polarized Light.*—Dr. J. Schaffers obtained from experiments made on fossil teeth with polarized light results perfectly analogous to those previously obtained from fossil bone, and considers that the explanation of this optical effect is due to the fibrillar structure of both substances. The author's results do not accord with those of Valentin, who found that fossil and recent teeth behaved in the same manner to polarized light, while the author considers that the reverse is the case.

Böhm and Oppel's Manual of Microscopical Technique.†—This little work is intended for beginners; it is divided into two parts, the first of which deals with the Microscope and its manipulation, the second part is subdivided into general and special sections. In the former are considered methods of preparation, fixation, hardening, imbedding, sectioning, and staining. The special section deals systematically with the various organs and tissues.

* SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 146–52.

† 'Taschenbuch der Mikroskopischen Technik.' München, 1890, 8vo, 155 pp. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 175–6.

PROCEEDINGS OF THE SOCIETY.

Meeting of 15th October, 1890, at 20, Hanover Square, W., the President (Dr. C. T. Hudson, LL.D., F.R.S.) in the Chair.

The Minutes of the meeting of 18th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Jelly, E. C., A Synonymic Catalogue of the Recent Marine Bryozoa, including Fossil Synonyms. xv. and 322 pp. (8vo, London, 1889)	*Miss E. C. Jelly.*
Marktanner-Turneretscher, G., Die Mikrophotographie als Hilfsmittel naturwissenschaftlicher Forschung. vii. and 344 pp., 195 figs. and 2 pls. (8vo, Halle a. S., 1890)	*The Author.*
200 slides of Marine Bryozoa	*Miss E. C. Jelly.*
12 Photomicrographs of Diatoms, &c.	*Dr. Giorgio Roster of Florence.*

Attention was called to a donation of special importance, consisting of 200 slides of Marine Bryozoa, from Miss E. C. Jelly, who had recently published a catalogue of Bryozoa.

A work on photomicrography, in German, by Herr G. Marktanner-Turneretscher, by whom it was presented to the Society, was referred to by Mr. J. Mayall, jun., who said the author had dealt somewhat fully with descriptions of the various forms of heliostats, commencing with that designed by Meyerstein. This heliostat was, he thought, one of the simplest and least expensive in commerce, and he exhibited one and explained its construction. The modification required in the construction in order to meet Mr. Comber's suggestion, contained in his paper on a new heliostat published in the August number of the Journal, was to substitute for the existing mirror—which was simply of glass silvered at the back, and consequently gave two reflections—a more perfect reflecting surface. Mr. Comber recommended a plane mirror of speculum metal; but as such mirrors were difficult to obtain and costly, and, moreover, required great care in handling, Mr. Mayall thought that possibly a right-angled prism of white glass might be applied with advantage. Such a prism might be freely handled, and the internal reflection from the hypothenusal face would be extremely bright and free from colour. Another such prism might replace Mr. Comber's fixed speculum mirror for deflecting the light from the heliostat mirror into the axis of the Microscope supposed to be horizontal. Probably the most efficient way of dealing with the matter practically would be to bring it to the notice of the mechanician who supplied Meyerstein's heliostat, which he (Mr. Mayall) would endeavour to do.

Mr. Mayall also directed attention to the donation of 12 photomicrographs by Dr. Giorgio Roster, of Florence, some of which appeared to him excellent specimens of work produced with Zeiss's apochromatic

objectives, using sunlight with an achromatic condenser in the axis. The inspection of these photographs reminded him that in discussing the production of such work recently with Mr. Comber, they were agreed upon the advantage of using sunlight, as compared with the oxy-hydrogen lamp, from the fact that when the image of the sun was focused on the object by a properly constructed achromatic condenser, the illumination was perfectly even over the whole field from centre to margin; but with the oxy-hydrogen light, focusing the illumination really resulted in the projection upon the object of an image of the incandescent spark and its immediate surroundings in the lime-cylinder, which image always consisted of a brightly luminous point encircled by a more or less mottled or cloudy appearance, representing the adjacent parts of the lime-cylinder that were not so highly luminous, on which the gas-jet was not so active. Doubtless, in the hands of a skilled manipulator the difficulties in the use of the oxy-hydrogen light were corrected as far as practicable; still, there always remained an element of uncertainty in its use, demanding incessant watchfulness; the light would vary in momentary intensity, or would flicker and become decentered, and the resulting photograph would embody not only an image of the object, but very frequently this would be mixed up with irregular mottled appearances which were in reality projections of the ever-varying condition of the source of light—the more or less incandescent parts of the lime-cylinder. The evenness of the solar illumination was well shown by Dr. Roster's photomicrographs, though he thought in some of them—notably in that of *Surirella gemma*, the condenser was not quite accurately centered. The greyness in some of them was probably due to errors in the photographic manipulations.

Mr. G. F. Dowdeswell's note on "A Simple Form of Warm Stage" was read, and the apparatus exhibited. It consisted of a thin, flat, quadrangular plate of copper, having a projection of about 6 in. at one of the front corners; an aperture was made in the centre to correspond with the aperture of the Microscope stage, and a copper tube was soldered across the surface near the back edge, in which a clinical thermometer could be inserted. In use the copper plate was to be clamped on the Microscope stage, and a spirit-lamp adjusted to heat the metal projection, and, by conduction, the preparation on the stage.

Prof. C. Stewart inquired if the copper plate was intended to rest upon the metallic stage of the Microscope? If so, he thought there was likely to be a considerable loss of heat by conduction.

Mr. G. C. Karop said that a piece of flannel or cloth was usually placed between the two. He thought the great fault of all such things was that no means existed for controlling or maintaining the temperature at any given point, so that when the observer was looking closely at some object of great interest he was very apt not to notice the rise of temperature, and the result was that it got so hot that the thermometer would break, to say nothing of what became of the object. What was wanted was a self-regulating warm stage, which would maintain a given temperature, supplied at a price within the reach of the bulk of medical students.

The President said he had, with great regret, to record the deaths of two Honorary Fellows of the Society—Mr. Kitchen Parker and Mr Ralfs. The former gentleman was so well known to them by the work which he accomplished, and for the enthusiasm with which he entered upon his researches, as well as from having been at one time President of their Society, that it was unnecessary for him to refer to him at any length on that occasion. They would all feel that, in losing him, they had lost a very valuable friend and fellow worker. Mr. Ralfs was elected an Honorary Fellow of the Society only a short time ago, and, in fact, died before he had received an intimation of his election. In place of these two gentlemen, the Council had nominated as Honorary Fellows—Dr. Henry Brady and Prof. Williamson, FF.R.S.

Referring to the explanation he had given at the June meeting regarding the new objective of 1·6 N.A., presented to the Society by the firm of Carl Zeiss, of Jena, **Mr. Mayall** said he must ask the indulgence of the meeting to enable him to clear himself from possible ambiguity. In notifying the fact that at the first photographic trials of the objective, the visual and actinic foci were found by Mr. Nelson and himself to be not coincident, and that when the objective was returned to Jena immediately after, Dr. Czapski, of the firm of Zeiss, found the foci were coincident, the explanation of the extraordinary divergence on the point seemed to him of the nature of a puzzle, which, for the moment, appeared inexplicable. He had, therefore, hazarded what he had imagined would appear a mere playful admission of the state of general puzzlement of both sides by suggesting that *the transit of the objective from London to Jena had somehow got rid of the "chemical" focus.* That sentence had unhappily been construed, both in England and abroad, into a reflection upon the good faith of Dr. Czapski, or upon Dr. Abbe, or upon the firm of Zeiss. Whatever blame was due to himself for the ambiguity of the expression, he must of course accept. At the same time he thought the Society would be interested to learn that upon his conveying his explanation to Dr. Czapski and Dr. Abbe, those gentlemen had expressed their complete satisfaction with it. The interchange of correspondence on the subject had led him to consider closely the whole circumstances, and he believed the existence of the "chemical" focus was probably due to a slight difference in the adjustment of the front lens, the mounting of which was partially unscrewed from the body of the objective when it first reached his hands, and which he might not have set exactly in the normal position in which it left Jena. On his suggesting this explanation of the difficulty to Dr. Abbe, its possibility was at once admitted, especially, as Dr. Abbe pointed out, in view of the fact that with an objective of such large aperture the colour-correction was, as it were, "balanced on a needle-point" in the matter of an alteration in the distance of the front lens from the posterior combinations; and that a very minute alteration in that distance, though producing no perceptible difference in the visual image, was quite competent to lengthen or shorten the focus of the violet rays to such an extent as to exhibit a "chemical" focus non-coincident with the visual focus when tested photographically. It appeared that when the objective was returned to Jena, it was not examined optically in the precise con-

dition in which it was received, but was first put on the lathe and all the lens cells unscrewed and separately examined, which was the usual course adopted when an objective was returned for inspection. In setting the objective up again the foreman intrusted with the task would, no doubt, screw the lens cells together again exactly as they were originally when the objective was first despatched from Jena, and it was in that condition when Dr. Czapski tested it and reported that the visual and actinic foci were coincident, which was subsequently confirmed by the second photographic trials made with it in London. Mr. Mayall read portions of the correspondence he had had with Dr. Abbe and Dr. Czapski relating to the subject; but he thought the matter would hardly require extended publication. The point of interest to the Society was to be informed of the progress of the report of the committee on the new objective. The committee had not been able to meet during the vacation, and he regretted to have to state that the new slide forwarded by Dr. Van Heurck, in June, had become partially opaque like the one originally received with the objective. Dr. Van Heurck had recently found that the flint cover-glass became injured by the prolonged exposure to the great heat required in mounting the objects in the dense yellow medium, and he had promised to forward another slide prepared with a different kind of flint cover-glass, with which he anticipated less difficulty in securing permanency in the mounting. Until the arrival of the new slide, the committee could not usefully proceed with the examination of the new objective.

The President gave formal notice that a special general meeting would be held in the Library at 5 p.m. on Wednesday, the 22nd inst., for the purpose of considering alterations in the bye-laws, the terms of which he read.

Mr. G. C. Karop exhibited and described an improved student's Microscope, made, at his suggestion, by Swift and Son. The new instrument embodied Nelson's "horse-shoe" stage for convenience of readily seeing the condenser, and for estimating by the touch the approximation of the focus on the slide; on this stage the Mayall mechanical stage was easily applied. A centering substage was also adapted, which focused by sliding on the tail-piece. The whole instrument was of superior workmanship and design, and supplied at a moderate price.

Mr. E. M. Nelson entirely approved of the aim of the design of the instrument. The general strengthening of the bearings throughout the mechanism was an important element in a Microscope for the use of students. He thought the plan of focusing the condenser by sliding it on the tail-piece was not good; but should be replaced by a rack and pinion, which would add little to the cost.

Mr. T. F. Smith said that all his own work in photomicrography had been done with a similar instrument; but he thought that for high powers some rather more delicate kind of focal adjustment for the condenser would be essential.

Prof. J. W. Groves read a note by Mr. Percival C. Waite "On a New Method of Demonstrating Intercellular Protoplasmic Continuity."

A specimen in illustration was exhibited. He remarked that though most microscopists were anxious to get rid of air from their specimens, Mr. Suffolk, who had looked at this one before leaving the meeting, said that he had found its presence in some cases desirable, and for this purpose, having prepared his section, he placed the slide upon his hand and, after allowing the air to enter, he mounted it in Canada balsam. Specimens like the one exhibited could by this process be multiplied *ad infinitum.*

Mr. J. D. Aldous exhibited some early forms of Microscope slides made of boxwood, similar to those which were formerly made of ivory with the objects between pieces of talc. In those shown, cylindrical cavities were cleanly bored in the boxwood slip, and the objects stuck upon paper at the bottom of the wells so made. Some of the objects were excellent specimens, a beetle being particularly well set up.

The President called attention to some original drawings of a new Rotifer by Mr. W. B. Poole, of South Australia, who was present at the meeting. He also mentioned that a specimen of *Œcistes mucicola* was exhibited by Mr. G. Western. This rotifer had also been found by Mr. Parsons. With regard to *Trochosphæra* he might say that it was really an *Œcistes*, and that it had been found in Australia together with the male. These things had such a way of appearing in different parts of the world that, as had been the case with some others, now that it had been found in Australia, it would doubtless be found in London before long.

Mr. E. M. Nelson exhibited upon the screen a series of 31 photomicrographs, which he described.

The President felt sure he should be right in expressing to Mr. Nelson the great pleasure which it had given them to see these beautiful illustrations, accompanied as they had been by his vigorous explanations.

Mr. H. B. Brady's paper "On a New Type of Foraminifera" was taken as read, as it was published in the current number of the Society's Journal.

Dr. Maddox's paper, "Some observations on various forms of human Spermatozoa," was postponed until the next meeting, in consequence of the lateness of the hour.

The President took the opportunity of congratulating the Fellows upon the improvement which had taken place in the appearance of the room since they last met, and expressed a hope that it might be taken as an earnest of many pleasant meetings to come.

The following Instruments, Objects, &c., were exhibited:—

Mr. T. D. Aldous:—Series of early Micro-slides.
Mr. G. F. Dowdeswell:—Warm Stage for the Microscope.
Prof. J. W. Groves:—Radial Section of Stem of Horse-chestnut.
Mr. G. C. Karop:—Swift Microscope.

Mr. E. M. Nelson :—Photomicrographs of Diatoms.
Mr. J. Mayall, jun. :—Meyerstein's Heliostat.
Mr. W. B. Poole :—Drawings of a new Rotiferon from South Australia.
Mr. P. C. Waite :—Longitudinal Section of stem of Horse-chestnut.
Mr. G. Western :—*Œcistes mucicola* Kellicott, from Richmond and Staines.

New Fellows :—The following was elected an *Ordinary* Fellow:—William Ombler Meek, M.B.

MEETING OF 19TH NOVEMBER, 1890, AT 20, HANOVER SQUARE, W., JAMES GLAISHER, ESQ., F.R.S., VICE-PRESIDENT, IN THE CHAIR.

The Chairman having declared the meeting to be made special for consideration of matters adjourned from the special meeting held in the Library on Wednesday, October 22nd, at 5 p.m.,—

The Minutes of that special meeting were read and confirmed, and were signed by the Chairman.

Prof. Bell said that the meeting would understand from the minutes just read that the object of the special meeting was the making of a new rule, to be called Rule 54, which, if adopted, would make certain alterations in the powers of the Fellows of the Society. He could only say that the matter referred to was still under the consideration of the Council, who were at present unable to make any recommendation concerning it. Under these circumstances it would, perhaps, be advisable to defer it to a future meeting.

It was then moved by Mr. J. M. Allen, seconded by the Rev. Canon Carr, and resolved, "That this special meeting be adjourned until Wednesday, December 17th, at 8 p.m."

The Chairman having declared the special meeting adjourned and the ordinary meeting constituted,—

Prof. Bell announced that the President was confined to his bed by bronchitis.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Dick, A. B., Notes on a New Form of Polarizing Microscope. 56 pp. and 1 pl. (8vo, London, 1890)	*Mr. F. Crisp.*
Giltay, E., Sept Objets regardés au Microscope. xi. and 67 pp. and 6 pls. (8vo, Leyde, 1890)	*The Author.*
Neuhauss, R., Lehrbuch der Mikrophotographie. xi. and 272 pp., 3 pls. and 65 figs. (8vo, Braunschweig, 1890)	*Mr. H. Bruhn.*
Shells from West Indies	*Mr. T. Christy.*
3 Photomicrographs and 4 Negatives	*Surg. V. Gunson Thorpe, R.N.*
Slide of Marine Annelid	*Surg. V. Gunson Thorpe, R.N.*
Photomicrographs of *Bacterium Termo*	*Mr. A. Pringle.*

Mr. J. Mayall, jun., created some amusement by reading from 'Nature' an advertisement of a newly-invented Microscope, and exhibiting the article to which it referred, with comments upon his experience as a purchaser.

Mr. Andrew Pringle having sent to the meeting two photographic prints showing the flagellum of *Bacterium Termo*, they were handed to Dr. Dallinger with a request for his opinion.

Dr. Dallinger said that there was no doubt that the flagellum was quite clearly seen in these photographs, but it was, as indeed was always the case in photographs, prolonged wonderfully, and presented an extremely rotten or imperfectly defined edge. Prof. Abbe had taught them that in looking at an object so minute as this, they were really looking upon a diffraction image of it rather than upon the thing itself, and that this image was always seen as something larger than the real object. How this affected the photograph he was unable to tell, from want of a thorough knowledge of the process, but he knew that when looking at such an object with any power from 1/8 in. up to 1/50 in. with a numerical aperture of 1·47, a clear and sharp definition was obtained of the flagellum, which appeared to be about one and a-half times the length of the body. Here in the photograph it extended a long way beyond this, giving him the impression that there might be two interlocked. At any rate, there was great skill shown in the production of these pictures.

Prof. Bell said no doubt the Fellows of the Society had carefully read an article in the last number of the Journal on the Retinal Image of the Insect Eye, in which mathematical formulæ were given and woodcut illustrations to show the nature of the image produced by the compound eye of an Insect. Prof. Exner, the author of the memoir noted, had sent to Dr. Sharp a photograph of the image so produced, and Dr. Sharp, in the most friendly manner, had placed it at Prof. Bell's use for exhibition that evening. It would be remembered that, as a result of his investigations, Exner arrived at the conclusion that a single erect image was thrown upon the retina of the compound eye of an insect. From time to time various theories have been advanced, but that of Johannes Müller, that patches of images on a kind of mosaic plan were produced, seemed to still "hold the field." The photograph exhibited shows—and its evidence is corroborated by mathematical calculation—that it is perfectly certain that the retina of an insect does receive a single image just as we ourselves receive a single image on the retina of each of our eyes. In our own case we have to learn rightly to estimate the position of objects, for the image which we receive is inverted, but in insects it seems that the image which is received is single and is also erect. In that it is single it is the same as our own, but in that it is erect it differs. In the taking of the photograph the eye of the insect was pointed towards a window—the letter R was put on one of the window-panes, and there was a church outside. In the photographed image the letter R is plainly seen, and the church is visible. The photograph was handed round for inspection.

Mr. A. T. Watson's paper, "On the Tube-building habits of *Terebella littoralis*," was read by Prof. Bell, and drawings and museum specimens in illustration were exhibited to the meeting.

Dr. Dallinger said that he had watched for hours together with Mr. Watson in observing the development of these tubes in much earlier stages than had been mentioned in the paper; this was about four years ago, and since then the author had done very valuable service, some of the results being embodied in this paper. It was also of much interest, as showing how a man not specially devoted to biological work might adapt himself to it, so as to attain very useful results.

Prof. Bell thought this was just the kind of paper their President would have been glad to hear, as it seemed to fulfil the idea that he had in his mind when he gave his last annual address.

The Chairman said they were extremely indebted to Mr. Watson for his very interesting paper, and also to their Secretary for having induced him to write it.

The thanks of the Society were voted to Mr. Watson for his paper.

Surgeon V. Gunson Thorpe's paper, "On a New Marine Annelid," was read by the Secretary, who regretted that Surgeon Thorpe, R.N., was unable to be present, having been suddenly called away for service on the West Coast of Africa—though happily not in the 'Serpent.' The specimen exhibited was brought home from Australia, having been obtained, in 1887, off Gloucester Island, on the coast of Queensland. It had the appearance of a very curious tube-building Rotifer; but there seemed some doubt as to whether it might not be an Annelid.

Dr. Maddox's paper, postponed from the last meeting, entitled, "Some Observations on Various Forms of Human Spermatozoa," was read by Prof. Bell, drawings and photographs in illustration being passed round for inspection.

Mr. Dowdeswell's note on the same subject was also read, and a photograph by Mr. Andrew Pringle was exhibited.

Mr. E. M. Nelson said he had worked a good deal at this question some time ago, and then found many curious points in the structure of these bodies, which he found to be constant, but which were passed over in these drawings. There was one thing which he thought most important, as to the shape of the head; it was really shaped as if set in a kind of cup, and it had a small spike upon the top. This feature was not represented, but then, as Mr. Pringle's specimen was stained, it was therefore utterly destroyed for all purposes of minute examination, though the staining made the filament more distinctly visible. There was also a distinct joint at the foot, which was not shown, and there were also what he called vacuoles—though perhaps they were not vacuoles at all—and he had not only seen the nucleus in the vacuoles, but he had seen the divided nucleus as well. When he first saw the filament on the head he recognized at once the analogy to that which he had seen in the spermatozoa of the newt, where it was shown to have a distinct bulb, which was no doubt the means by which it attached itself to the ovum. In order to discover if this also existed in the human spermatozoon, he had worked at it for a whole week until he succeeded

in finding the barb on the end. This barb he thought clearly showed the analogy which ran all through the whole of those things. He might also mention that Dr. Gibbes had demonstrated a curious thing on the tail of a spermatozoon, a kind of spiral thread encircling it. Mr. C. Beck and Dr. Gibbes had made this out, and shown nine turns in this curious wiry thing. This had on a former occasion been exhibited at the Society in one of Dr. Gibbes' preparations.

The Chairman said he felt sure they would give all due credit to Dr. Maddox for the way in which he had worked at this somewhat difficult subject, although he might not have noted some of the things mentioned by Mr. Nelson. Personally, he found that with advancing age his own eye had lost something of its delicacy of perception. Their thanks were due to the author for the paper which they had heard read, and also to Mr. Dowdeswell for his note on the subject, and to Mr. Nelson for his further explanations and remarks.

Mr. E. M. Nelson then exhibited and described—

(1) An elementary centering apparatus for use on the substage of cheap students' Microscopes.

(2) Photographs illustrating the secondary structure of *Navicula*, taken with a 1/8 in. objective N.A. 1·4, × 1430; also another of the same × 800, taken with direct light; also of proboscis of blowfly, with Zeiss's new apochromatic $1\frac{1}{2}$ in., and the same taken by an ordinary cheap object-glass, which really produced the better picture of the two, in consequence of the very small angle in Zeiss's lens; also the same by a new apochromatic lens, by Reichert; also three photographs to show the same diatom as seen with 1 in., 1/2 in., and 1/4 in. objective; also a high-power view, showing the test on the proboscis of the blowfly; also one of *Navicula spectabilis*, showing new structure, with Powell's 1/4 in. apochromatic, and one of *Synedra*, taken with a 1/8 in. objective.

(3) "A Note on Bacteria," showing by means of photographs the flagellum of *Spirillum* × 1350 as single, and as divided into two and into four.

The thanks of the meeting were given to Mr. Nelson for these communications.

The following Instruments, Objects, &c., were exhibited:—

Dr. H. L. Maddox:—Photographs in illustration of his paper.

Mr. J. Mayall, Jun.:—Premier Microscope.

Mr. A. Pringle:—Photomicrographs of *Bacterium Termo*.

Surgeon V. Gunson Thorpe:—(1) Photomicrographs and negatives in illustration of his paper; (2) Slide of Marine Annelid.

Mr. A. T. Watson:—Specimens and photographs in illustration of his paper.

Mr. G. Western:—*Dinops longipes* Hudson.

New Fellows:—The following were elected *Ordinary* Fellows:— Messrs. Wynne E. Baxter, J.P., Henry Berger, William Rutherford, M.D., F.R.S., D. E. Haag, M.D., Henry R. Saunders, and J. Christie Wright. Dr. Henry B. Brady, F.R.S., and Prof. W. C. Williamson, F.R.S., were elected *Honorary* Fellows.

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LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
STAMFORD STREET AND CHARING CROSS.